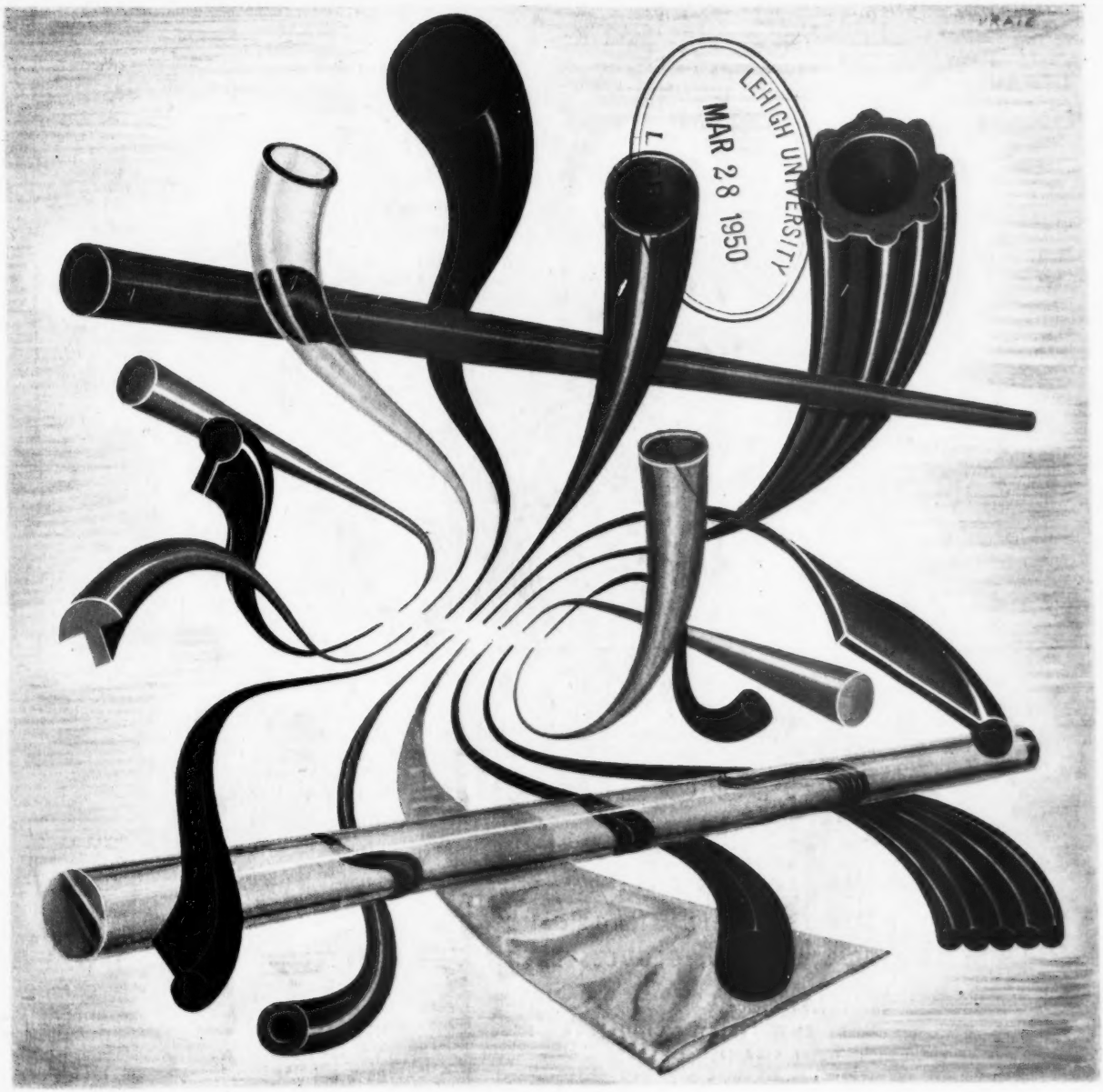
Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS



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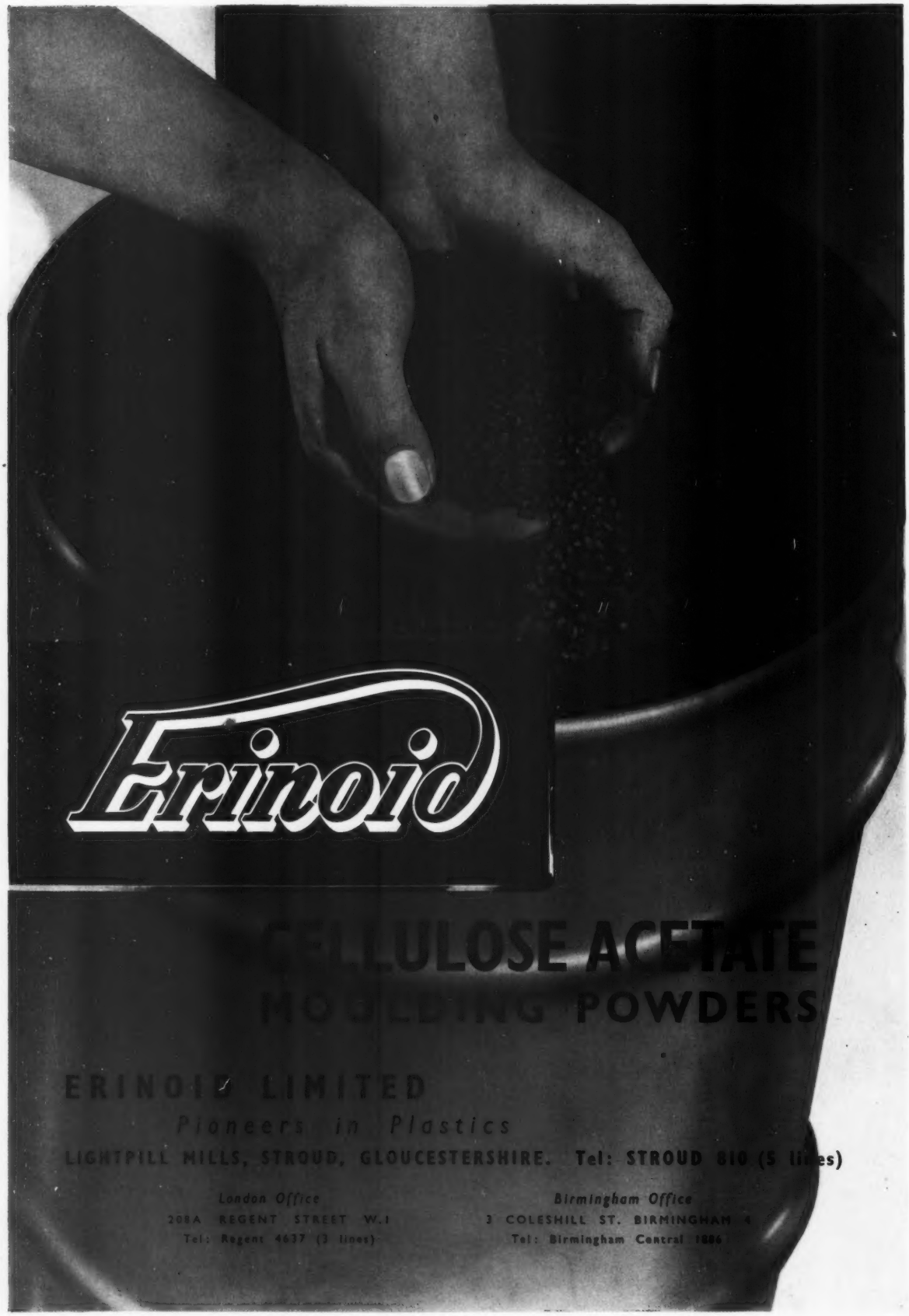
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Plastics

VOL. XV. No. 154. MARCH, 1950

" And I have often thought, that probably there might be a way found out, to make an artificial glutinous composition, much resembling, if not full as good, nay better, than that Excrement, or whatever other substance it be out of which, the silk-worm wire-draws his clew. If such a composition were found, it were certainly an easie matter to find very quick ways of drawing it out into small wires for use. I need not mention the use of such an Invention, nor the benefit that is likely to accrue to the finder, they being sufficiently obvious. This hint, therefore, may, I hope, give some ingenious inquisitive Person an occasion of making some trials, which if successfull, I have my aim, and I suppose he will have no occasion to be displeas'd."

Robert Hooke, " Micrographia," 1667.

EDITORIALS

The Chemical Industry

ON page 64 we give a very general analysis of the Report on the Chemical Industry, just published by the Association of British Chemical Manufacturers. It was compiled at the request of the President of the Board of Trade, and we urge its careful examination by all readers. If only it would become a best seller down Whitehall way!

Mr. Harold Wilson needed the mass of information given in the report to guide him in estimating the probable extent and direction of our future internal and external trade in chemicals, but since other spokesmen of the Labour Government have from time to time intimated their desire to nationalize the chemical industry the report contains adequate food for thought on this very contentious subject.

The reasons given for the desirability of nationalizing industries have included the evils of private ownership and the blessings of public ownership on general grounds, the evils of private ownership on special grounds since " it leads to monopolies and malpractice," and the need for public ownership on the grounds of inefficiency of private ownership. There is often also a reason special to the chemical industry: because chemical science is considered unbridled and can produce dangerous materials varying from poison gases to atomic and hydrogen bombs. With this last stupid but widely accepted " good reason " we shall not deal except to intimate that statesmen and politicians may often prove to be the unbridled. Nor is this the place to discuss politics.

But this *is* the place to discuss the efficiency or inefficiency of the chemical industry, and if this were the deciding factor, surely there would be no more talk of nationalization.

The chemical industry may be considered to go back to the end of the 18th century as a direct result of the Industrial Revolution or, more particularly, the growth of the cotton and wool industries. Based almost completely on chemical research, it has always been dynamic; it cannot be, like other industries, intermittently static. It must keep pace with the growth of the science chemistry (and also now the sciences of physics and mathematics) that determine its own existence. It must shed old products and methods and rapidly acquire new uses. In no other industry has there always been a strong natural flow of knowledge, nationally and internationally, and in no other industry has this knowledge been so widely applied. In no other industry are so many academic workers employed, nor so many technical scientists applying their results, first on pilot plants and then finally in the factory. In no other industry are so many engineers trained in the specific work of designing chemical plant; in no other industry are so many scientific instruments used in the control of chemical production.

As the report says: " More perhaps than any other industry, the chemical industry is a continual venture into the unknown. For the successful prosecution of the necessary experiments and speculations, wide in their scope and often profound in their complexity, there is needed an intricate balance of individual inspiration, personal faith and corporate courage."

To carry out all the research—we shall not refer to the vast capital outlay on the special plant, instruments and greater personal control necessary—much money is needed, and, happily, this expenditure is considered not as a burden or part of the profit which should be distributed to shareholders, but as a clearly seen necessity to keep in the forefront of scientific production. Yearly expenditure on research is now £8,500,000 and soon it will rise to £11,000,000 and more.

Monopoly

ONE section in the report is devoted especially to the above subject, which always arises when considering nationalization of the chemical industry, the inference being that monopoly is *ipso facto* an anti-social act, the word being, in the mind of the public, synonymous, with the ability to raise prices at will and to resist entry of other manufacturers into the same field. Anti-social acts by " cornering " have often taken place in history, but there has been more than a little nonsense talked about the evils of monopoly in industry, which is a very different thing. When it refers to the chemical industry it is more than normally nonsensical.

Monopoly there is, on a comparatively small scale, and refers to production exclusively or predominantly by a single firm. It may be the result of invention; it is often essential because of the small demand for a chemical, the need for specialized and costly plant and high technical skill and experience.

Sometimes the production of a chemical product with a big demand may be made under monopoly, and rightly so. Thus, for example, few would quibble that the manufacture of penicillin, because of its special nature and need of close control, would be permissible as a monopoly. To revert to small manufacture and of which we have more knowledge is the example of, say, thymol, the special costly germicide used in toothpastes and other pharmaceutical products and which is made by a very difficult and costly process from isopropyl alcohol and meta-cresol. The world consumption is about 200 tons (at least, it was that in 1939), and the world

was supplied with it by three firms, one in England, one in Germany, and one, we believe, in the U.S.A. Contrary to careless theoretical talk, increased production would probably not be absorbed, even if prices could be reduced. The process is inherently expensive and, furthermore, entry of additional manufacturers would probably result in all-round decrease in output and, therefore, decrease in efficiency of each plant, and, finally, in an increase in price. New uses of thymol are very unlikely, and in competition there are a host of other disinfectants and germicides, most of which are very common and much cheaper in price. It can be argued contrarily that the maintenance of many monopolies is very desirable. Above all, and increasingly so, there are, almost universally, competitive materials to maintain a balance.

The more thoughtful man in the street has in this Year of Grace 1950 some inkling as to the importance of the chemical industry, and perhaps of its complexity. Indeed, its products enter into every human endeavour, and often each product is used by many entirely different industries.

The chemical industry is truly the key to all other industries. But the key must always be kept bright. Beware lest it rust and break in the hand!

Plastics in the Textile Industry

OUR series "Plastics in the Service of Man," continues this month with a peep into the textile industry, where the impact of the new materials becomes clearer and more evident year by year.

It is true in the old industries of cotton and wool weaving spinning, when the shuttles and picking sticks and gearwheels are made of resin-bonded and impregnated laminates, and when bobbins and pirns of a hundred different shapes and sizes are moulded of phenolics, cellulose acetate and polythene to much closer tolerances than the wooden units they replace. It is true in the rayon factories, where plastics have long been used as spinning pots, reels and plates to resist the acid still clinging to the fibre as it issues from the coagulating baths.

The number of bobbins in action and in course of continuous replacement is enormous. So great is the demand that, quite apart from the usual moulders who supply them, some of the large spinning companies have their own presses. Indeed, one has over 70 presses moulding, amongst other units, 12,000 bobbins per week for its own consumption!

Tricresyl Phosphate

A FAMOUS industrial research organization has seen fit to report on the hazards of this plasticizing agent, which is so widely used in the manufacture of p.v.c., and has issued it to its members.

Now it is right and proper that all hazards in industry or hazards to the public should be divulged, but it is also essential that the whole evidence, and not merely part of it, should be reported.

As we published in the December, 1949, issue of this journal, there are, in fact, three cresyl phosphates—ortho, meta and para. It is the ortho cresyl phosphate that is suspect. On the other hand, it has been found by two German workers that meta and para cresyl phosphates are not toxic.

We made this clear enough, yet in commenting on our editorial the writer of the report referred only to the ortho and not to this important distinction, nor to the equally important fact that British manufacturers no longer produce the ortho compound.

This is a serious omission for a scientific organization to make. We are, however, pleased to announce that the report has been withdrawn from circulation for further examination.

MOULDING POWDER AND SHOT

—And Then the Word

I recently read somewhere that the word "Plastics" was discovered about the year 1914 by an American. As yet another example of the truth that nothing is new under the sun, I publish a photograph of an oldish book that has come into my possession and dated, as will be seen, 1824. The preface states: "On submitting to an enlightened Public a new, elegant and instructive amusement for Children, we have first to account for its name. We are aware that the term Plastics is generally confined to the modelling of sculptors and statuaries in gypsum, clay, wax, etc. But as the art of making cork models of architectural monuments on a small scale has obtained on the continent the appellation of *Phelloplastics*, from the Greek word φελλσς, cork; we think ourselves warranted by this analogy in denominating the art of modelling in paper *Papyro-plastics*."

Catch Them Small

Catch them big, so long as it is with "Luron" cast or line! A nation-wide competition for amateur anglers has been organized by Imperial Chemical Industries, Ltd., and opens in April, 1950. Prizes of £20 and £5 will be awarded each month for the best specimen caught by an amateur in the British Isles on "Luron" (nylon) cast or line. The specimen need not necessarily be the heaviest fish, for locality and other factors will also be considered. The competition will continue until March, 1951, each month being a separate competition devoted to the fish of the month, beginning with trout and ending with salmon. Entry forms from "Luron" Angling Competition, Imperial Chemical Industries, Ltd., Plastics Division, Welwyn Garden City, Herts. It is expected that "Luron" will be responsible for more "whoppers" than ever before.

* * *

High Jinks in Park Lane

More than 280 members and guests of the moulders' section of the British Plastics Federation were present at the Dorchester Hotel in Park Lane, London, on the occasion of their annual dinner and dance, and, as Damon Runyon used to put it, "a good time is had by one and all." This was especially true, for there seemed to have been a pleasant conspiracy to impress upon everybody that they had come to eat, drink, dance, and to see a cabaret. The result was that never before had we listened to better speeches; each speaker knew what he had to say, said it and sat down. Lengths of speeches in seconds as estimated by my chronometer: Herbert Bridge, 25; Charles F. Merriam, 161; Charles Waghorne, 140; and the record holder, the Chairman, Norman Punfield, 12!

DOGSBODDY.

Experiment with Laminate at a Paper Mill

CERTAIN blemishes in finished paper are now being eliminated as a result of a successful experiment recently made by the Bathford Paper Mills Co., Ltd.

The hardwood breast box and trough on a papermaking machine in this West Country mill had for some time been unsatisfactory in performance. The rate of flow of paper stock coming from the beater was sufficient, when coupled with the chemical action of the pulp liquors themselves, to lift the fibres of the wood. The lifted wood fibres trapped fibres in the paper stock so that a lump gradually accumulated. The flow of stock past this lump eventually caused it to break away, and marks or holes in the finished paper sheet were the inevitable result.

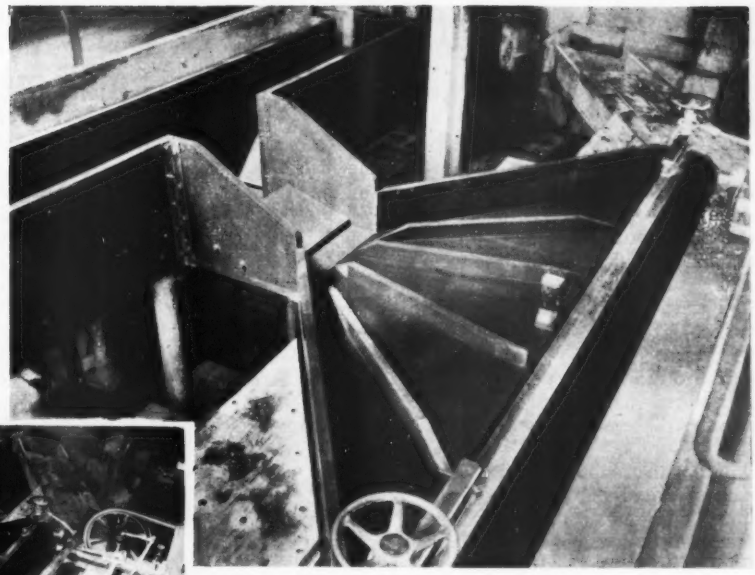
The introduction of a trough, breast box and delivery board made from Bakelite laminated fabric-based sheet, however, has overcome this trouble.

This laminate is made by impregnating fabric with a synthetic resin, cutting the impregnated material into standard size sheets and forming many such sheets into solid boards under heat and pressure. The resulting boards combine the strength of hardwood with certain other important advantages. In the first place, the steel plates between which Bakelite laminated is pressed in the course of its manufacture impart to the finished board an exceptionally smooth surface. Secondly, the material does not corrode, is unaffected by most chemicals, and is impervious to acids and mild alkalis. It is therefore completely immune from attack by the chemicals found in pulp liquors.

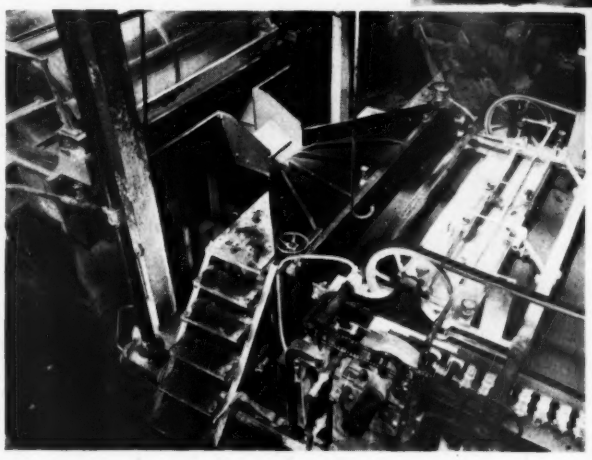
These properties have been strikingly demonstrated at Bathford, where the Bakelite laminated breast box has been in continuous operation for a year, and the trough and delivery board for six months. Careful examination has shown that the surfaces of the new equipment are as smooth as when first installed.

The Bakelite laminate has been adopted for all components of the structure which come in contact with the paper stock. These include the trough from the screen to the breast box; the weirs in this trough which gradually lower the level of the stock; the spreader bars which ensure an even distribution of paper stock over the whole width of the breast box; the baffle board in the breast box itself; and the removable delivery board. The whole structure is securely jointed with stainless steel set screws.

Although use of "Bakelite laminated" for this particular application is unique, this material is already widely used in paper and board mills for suction box tops, pulp paddles and scrapers, beater cover linings, gears, water-lubricated bearings and pump parts. It is tough, dimensionally stable, and will successfully withstand rough treatment, and all standard machining operations can be performed on it with standard woodworking tools. It therefore offers the paper industry all the advantages of hardwood without one of its principal disadvantages, namely, imperfect resistance to chemical attack. Availability at the present time, when hardwood is in such short supply, is of particular importance.



(Above) This close-up view of the trough and breast box illustrates the use of "Bakelite laminated" fabric-based sheet as a constructional material.



(Left) General view of paper-making machine showing position of trough, breast box and delivery board.

Book Review

Engineering Laminates. Edited by A. G. H. Dietz. Pp. 797. New York: John Wiley and Sons Inc. London: Chapman and Hall, Ltd. 60s. net.

The first page of this excellently produced book contains an illustration of a fragment of Egyptian laminated wood of the 18th dynasty (about 1500 B.C.) This gives some idea of the importance of laminates throughout the ages.

Dr. Dietz, of the Massachusetts Institute of Technology, with the aid of some 24 other experts, has compiled an immense amount of technical information on all types of laminates—metals, glass, and organic materials. Included are adhesives, plywood, the plastic-based laminates, sandwich-type building boards, plastic-surfaced plywoods, rubber laminates, moulding laminates and sandwich materials. Each description is accompanied by methods of manufacture, data regarding physical, mechanical and chemical properties, and the use and conditions in use in the engineering world.

Plastics Trends in Australia

By CHARLES LYNCH

PLASTICS trades are sharing in the current expansion of industry in Australia produced by the back log of unfulfilled orders, and the general growth of the Australian economy.

The plastics trade generally is concentrating on utilitarian lines, and attention is being directed towards informative labelling of the products and a plan for quality certification of the articles produced by the increasing number of the factories.

At present the local productive capacity of phenolic is sufficient to meet demands, but urea moulding powder is not manufactured in sufficient quantities to meet requirements, although it is expected that this position may be reached in the near future.

On the thermoplastic side of the industry, injection moulders have been restricted by the effect of the dollar shortage on imports of their materials. American polystyrene has been supplied on a quota system, but is not sufficient to meet demand.

The commercial manufacture of cellulose acetate will shortly be undertaken by the Colonial Sugar Refining Co. of Sydney. The United States of America is the main source of supply of cellulose acetate, and the dollar position has made local manufacture an urgent necessity.

It is estimated by one of the largest suppliers of powders to the local industry that there are now about 200 compression moulders in the Australian trade. Compression, or transfer moulding of thermosetting materials for the production of radio cabinets, electrical apparatus and industrial components, is extending rapidly.

Some of the problems in the supply of equipment are steel shortages, and some lack of uniformity in the steel supplied to the machinery makers.

Of technical interest in the pressure-moulding field is an army service rifle, made of impregnated canvas in the phenolic-bonded process, which was developed during World War II when suitable wood was in short supply. The synthetic material was found to be an excellent substitute for wood, and although there is now no demand, the product has possibilities if wood supply conditions are repeated.

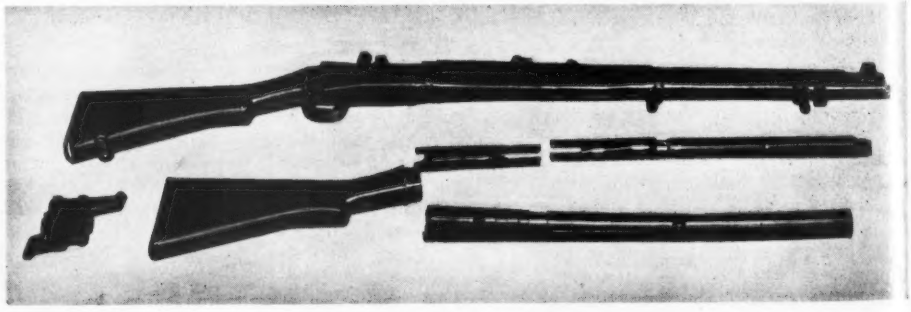
A recent introduction to the trade is rapid-hardening casting resins, which have been highly successful for the production of foundry patterns, jigs, dies, plating shields and other items of interest to engineers.

The injection-moulding industry is small but is growing rapidly. Of interest in this field is the successful production in Adelaide, South Australia, of large plastic containers for chemicals. With the use of polythene, the process is claimed to be an advance on overseas methods. The containers are also stated to be the largest injection mouldings made in Australia. Polythene is one of the least-known plastic materials. During World War II it was used as the key material in radar production, and is one of the best high-frequency insulators. It has very strong resistance to chemicals and weak acids, and has thus a future in the manufacture of the containers for marketed supplies of chemical manufacturers.

Many local moulders are interested in polyvinyl chloride for vinyl-coated fabric and vinyl composite flooring. At present it is marketed largely as a calendered sheet, for the making of household and personal products, and is a partial competitor with rubber.

There are several important new factory projects. Moulded Products Pty. Ltd., of Richmond, Victoria, is building two new

Children's toys moulded in p.v.c. in two parts and welded together. The doll at rear has movable head, arms and legs. The tortoise and alligator have valves for inflation purposes. The "dog" handbag is a distinct novelty. (Moulded Products Pty. Ltd.)



Army rifle parts made of impregnated canvas as a substitute for wood. These were produced during World War II, when there was a shortage of suitable wood; phenolic bonded resin was used in the manufacturing process. Moulded Products Pty. Ltd., Richmond, Victoria.)

factories at Lilydale and Frankston, in the State of Victoria, of 11,000 sq. ft. and 13,000 sq. ft. respectively. When completed, the company, through its subsidiaries, will control 21 factories in the various Australian States.

Beetle-Elliott, Ltd., of Sydney, is preparing to produce in Preston, Victoria, 500-600 tons annually of their various moulding powders. Resins for local requirements are to be made at the same factory. Later manufacture will probably be transferred to Highett, one of the outer suburbs of Melbourne, where the company has acquired a 12-acre site. Phenolic moulding powders and resins and the bulk of the company's output of amino powders, cements and resins are produced at its Rozelle factory in New South Wales.

Claimed to be one of the largest injection-moulding organizations in the Southern Hemisphere, the firms of Messrs. Piercy and Ashwood and A. B. Levee and Co. are bringing their various factories under one roof in East Willoughby, Sydney. For this purpose, a new £250,000 company has been registered. The manufacturing organization commenced in 1945, making toilet and fancy goods, and it now extends to toys, kitchen and household utensils, refrigeration, electrical and radio components. Special plant now on order will allow extension into the fields of motor accessories and component parts.

Interesting applications of polyvinyl chloride are shown in a number of utilitarian and children's products now being made by one of the largest moulding companies at Melbourne, Victoria. The material has been successfully used by the company for the manufacture of cables and insulation wires, for aprons (upon which the fancy patterns have been silk-screened) and for diverse types of children's toys.

Australia has always been well to the fore in the last-mentioned field. The toys include a baby's safety rattle, which contains a valve for inflation of the toy; a tortoise, which can also be blown up in the same way; and a novelty alligator. The manufacturing method is to mould in two pieces, after which the materials are welded together.

Large-scale production of plastic piping for various industrial uses is being carried out in Melbourne. Uses are for carrying distilled water, for beer in hotels, and for fruit juices in cordial factories. It is under test for future use for both gas and water. It is six times lighter than metal and its installation cost is in line with that of metal piping.

A clock tower built of rose-tinted acrylic and illuminated from the inside is an inspiring example in Sydney of what can be accomplished in the field of outdoor beautification. The tower is erected on the Coogee Beach. It is 30 ft. high and occupies a prominent position on the beach promenade. Clock faces appear on each of the four sides, and it is a distinctive and impressive landmark, much admired by the holiday visitors to Sydney's popular seaside resort.

Plastics from Leather Scrap

THE production of plastic-like compounds from leather scrap has intrigued many chemists, and during the past 10 years considerable experimental work has been carried out on the conversion of this waste into a useful material.

So far the results of this research have not been too encouraging, owing to the poor quality of the finished plastics-leather compound or the uneconomical nature of the process employed. Although leather scrap itself is very cheap, having practically no re-use value at all, it usually requires grinding or disintegrating before treating with resin-forming chemicals or polymeric compounds.

In a recent patent, U.S.P. 2,464,282, by Morton Abrahams, there is disclosed an interesting process of converting leather scrap into compositions suitable for floor coverings, gaskets and insulating material, also shoe soles and insoles. The process entails de-tanning the scrap or removing the tanning chemicals, dehydrating the protein-like fibrous mass and thoroughly mixing it with vinyl polymer, acrylic esters or cellulose esters, and plasticizers in a Banbury mixer, and subsequent milling or calendering in the form of flexible sheets.

The leather scrap collected from tanneries, shoe factories and bag-making works is carefully sorted and the chrome-tanned leather is separated from the vegetable-tanned leather. It is only the chrome-tanned leather that is really suitable for processing. De-tanning is carried out by use of a 3 per cent. solution of phosphoric acid at 65 degrees F. According to the patentee, a wooden vat is used for de-tanning and the process takes about 40 hours, presumably some form of agitation being provided. About 18 lb. of 85 per cent. phosphoric acid and 600 lb. of water are required for 100 lb. of dry chrome leather.

At the end of the de-tanning operation the scrap is reduced to a stringy residue of fibre, which is well washed in several changes of water and then pressed or squeezed through rollers until no more than 65 per cent. moisture residue is left. This doughy, plastic mass is fed into a Banbury mixer and for 100 lb. dry leather some 50 lb. polyvinyl acetate resin and 50 lb. methyl acetone are added and mixing is prolonged for half an hour, or until the material is in a suitable condition for drying out. When removed from the Banbury mixer the plastics-leather, when lightly pressed, should become stringy and not tacky.

After drying and milling, carried out at about 150 degrees F., the product is calendered and drawn from the bowls as flexible thermoplastic sheets, which, it is claimed, may be moulded and shaped under heat and pressure.

Study of this process is profitable, as it would appear that certain improvements might well be introduced, for example, Rochelle salt (sodium potassium tartrate) is a more efficient de-tanning agent than phosphoric acid; the Rochelle salt acts best for this purpose in a neutral or alkaline condition. It is also possible that some of the acrylic esters might be preferable to vinyl polymer, as a very much wider range is available and the degree of polymerization may be fairly closely controlled.

Plastics Institute

ASSOCIATESHIP EXAMINATION, 1950

The first examinations for the Associateship of the Plastics Institute will be held on June 26 to 29, 1950 inclusive, in London at Acton Technical College, and in Birmingham, at Central Technical College. Candidates will be notified of the results during the week commencing August 7, 1950.

Application forms may be obtained from the Managing Secretary, Plastics Institute, Adelphi, Adam Street W.C.2, and must be returned not later than March 31, 1950, together with fee of £2 2s.

The standard of the examination will be London University B.Sc. pass degree, except in the case of Use of English and Industrial Administration. The examiners under the various sections are as follows:—

General Section: (i) English (W. Henderson Pringle, M.A., LL.D.). (ii) Industrial Administration (A. Roberts, Ph.D., M.Com.).

Section A: (i) Chemistry (Organic) (P. F. Holt, Ph.D., D.I.C., F.R.I.C.). (ii) Chemistry (Physical) (G. A. Cheesman, Ph.D., F.R.I.C., D.I.C., A.R.C.S.). (iii) Technology of Plastics (R. B. Harley, B.Sc., A.R.I.C.), (iv) Chemistry of Plastics (N. J. L. Megson, D.Sc., M.Sc., F.R.I.C., F.P.I.).

Section B: (i) Physics (Prof. J. A. Crowther, M.A., Sc.D., F.Inst.P.). (ii) Mathematics (E. G. Ternouth, M.A.). (iii) Technology of Plastics (R. B. Harley, B.Sc., A.R.I.C.). (iv) Physics of Plastics (R. F. Tuckett, Ph.D., F.Inst.P.).

Section C: (i) Properties and Strength of Materials (R. O. Boswall, D.Sc., M.Sc. (Tech.), M.I.Mech.E.). (ii) Mechanics of Fluids (R. O. Boswall, D.Sc., M.Sc. (Tech.), M.I.Mech.E.), *and* Theory of Machines (J. Pidduck, M.A., A.M.I.Mech.E.), *or* Electrical Technology (E. Hughes, Ph.D., M.I.E.E.). (iii) Technology of Plastics (R. B. Harley, B.Sc., A.R.I.C.). (iv) Plastics Machines and Mould Design (J. Butler, A.M.I.Mech.E.).

Report on the Chemical Industry

IN September, 1948, the President of the Board of Trade requested the Association of British Chemical Manufacturers to compile a comprehensive survey of the whole chemical industry, this survey to include its plans for development. He had already realized the complexity of the industry and therefore considered it one unsuitable for inquiry by the "working party" method adopted for certain other industries. In this he was wise, and the resulting report of 76 pages, which has just been published* by the Association little more than a year after the request, is a magnificent exposition of a great industry upon which so much of the economic structure of Gt. Britain, and much of the Empire, depends. No economic and scientific assessment of the industry of such magnitude has ever before been attempted and, having watched the industry and reported upon it for the past 30 years, we have no hesitation whatsoever in describing the report as a complete vindication of the value of applied chemical research. It is most opportune in that we are now seeing much more clearly the paths that lie ahead, because the industry is on the verge of leaping forward to new endeavours. At no previous stage in the 150 years of its existence has the chemical industry been so alive with the promise of future greatness.

The report embraces a vast field and begins with definitions, historical background, recent changes in the chemical industry (e.g., the growth of plastics, biological products, etc.), the industry's products and the situation regarding supply of raw materials. With the foregoing chapters we obtain an adequate picture of the rapid growth and the great complexity of manufacturers segregated into 17 groups, ranging from acids and alkalis to industrial gases, fertilizers, "heavy" organic chemicals, pharmaceutical and "fine" chemicals, dyestuffs, pigments, industrial explosives, chemicals for pest control, plastics, coal-tar distillation products, and miscellaneous materials not covered by the above.

Then follow chapters on research and development services, process development, patents and monopolies, location of factories, staff and labour relations, productive efficiency, distribution and selling organizations and, finally, of special significance, a section dealing with the future trends and economic expansion of the industry, analysed so far as each of the aforesaid 17 groups are concerned.

As for the plastics industry, which is so inextricably a part of the chemical industry, the view we obtain as to its present condition and future expansion is enlightening, and even exciting. Furthermore, when the production figures of plastics are compared with those of the mightiest of the other 16 groups, it will be seen we do not lag far behind.

In Chapter IV the achievements of the plastics industry are discussed, and here we have an extraordinary picture of the rapidity of the growth of our industry. In 1938 the annual production had reached 30,000 tons. Last year we published the output during 1946 as 80,000 tons, and now we are given the figures for 1948—130,000 tons. There has been no industry in Gt. Britain which has made such rapid progress. And if we require further encouragement, the table at the foot of this page, "Summary of Forward Plans," shows that the present capacity of plastics manufacture (Group 15) is 185,000 tons, and the ultimate annual capacity, when the forward plans are completed, will be 339,000 tons. It is, perhaps, more important to look on the value of this 339,000 tons production. In the same table it is given as £71,881,000, a figure which is 12½ per cent. of the total value of all chemical production and exceeded only by Groups 3 and 8 (inorganic acids and salts, and heavy organic chemicals).

In detail, the proposals for the expansion of the plastics industry are given in the following table:—

Proposed Expansion

Group 15.—Plastic Materials and Synthetic Resins

Number of firms in group: 38.

	Number	Estimated cost £
Schemes in progress	55	17,447,000
Schemes awaiting licence	4	553,000
Schemes still tentative	30	3,974,000
All schemes	89	21,974,000
Amount already spent		7,859,000

	Annual tonnage	Annual value £
Present productive capacity	185,738	37,741,000
Total productive capacity on completion of schemes	339,189	71,881,000
Decrease in imports	—	3,266,000
Increase in exports	—	7,022,000

Extra employees required: 4,500.

The larger tentative schemes, in decreasing order of capital cost, are for "Terylene" polymer, cellulose products, the vinyl-chloride group and polytetrafluoroethylene.

The stories of some of the individual plastics and what is proposed in the future are also given.

* Report on the Chemical Industry. Obtainable only from the Association of British Chemical Manufacturers, 166, Piccadilly, London, W.1. Price 5s.

Summary of Forward Plans

All values in £000's

Group	Number of firms	Schemes			Present annual capacity		Ultimate annual capacity		Additional employees	Imports—decrease in value p.a.	Exports—Increase in value p.a.
		Number	Total cost	Already Spent	Tons	Value	Tons	Value			
1	48	86	11,119	1,014	1,476,000	9,545	2,134,000	14,064	480	—	10
2	7	38	39,100	11,411	1,759,000	22,120	2,611,000	32,952	4,170	21	4,250
3	84	142	13,736	2,652	2,561,000	52,114	3,354,000	75,821	2,850	5,401	3,858
4	7	12	4,286	860	*—	8,608	*—	11,391	1,000	160	240
5	2	3	3,590	—	920,800	10,755	1,183,000	13,702	280	—	1,000
6	12	31	2,468	105	1,299,000	7,762	1,453,000	9,297	—20	563	—
7	1	4	11,600	—	172,000	2,626	710,000	10,171	1,680	4,100	1,360
8	40	128	42,794	10,444	848,000	62,572	1,668,000	136,646	3,880	9,153	8,538
9	52	103	7,131	1,463	*—	32,144	*—	56,119	2,110	975	8,956
10	52	57	1,862	407	*—	14,833	*—	23,038	1,230	1,681	4,063
11	26	59	16,381	3,155	195,700	38,308	237,900	52,610	2,330	1,219	4,729
12A	38	52	1,928	738	41,271	6,727	53,152	8,593	460	—	440
12B	22	27	3,215	304	268,690	21,710	333,990	27,147	650	10	1,303
13	1	10	2,031	—	*—	10,394	*—	12,743	—1,330	—	—
14	29	20	686	23	86,415	6,763	96,812	9,390	270	—	341
15	38	89	21,974	7,859	185,738	37,741	339,189	71,881	4,500	3,266	7,022
16	17	26	1,947	292	32,826	2,717	56,978	4,906	640	1,810	1,028
17		Outside scope of inquiry									
18	2	40	5,458	2,069	—	—	—	—	—	—	—
otal ..	†—	927	191,306	42,796	9,846,440	347,439	14,231,021	570,471	25,180	28,359	47,138

* Tonnage figures are not applicable to these groups. † Many firms have schemes in more than one group.

Polymethyl methacrylate. The first applications of the plastic were for dental products and for use in the moulding industry. By 1936 sales of sheet (" Perspex ") were becoming important, and by 1939 sufficient knowledge had been accumulated for production to be stepped up and kept in advance of the large requirements for war purposes; in the peak year these reached 4,700 tons. More recently many new applications for " Perspex " have been discovered, and to-day the output of sheet is again approaching the war-time peak.

Polythene. The first sample of polythene was synthesized in the U.K. in 1933 as an indirect result of studies of the chemical effects of high pressures. The translation of laboratory results to a manufacturing scale was difficult; enormous pressures, of the order of 1,000 atmospheres, were needed to induce the required polymerization of ethylene, and special techniques for handling them had to be evolved after systematic research. By 1936 most of the difficulties had been overcome and a continuous process had been developed; by 1937 a small laboratory pilot plant was running continuously; in 1939 the erection of a full-size plant was begun. Important war uses for polythene were soon found. The superiority of the Allied Nations' radar over that of Germany was, in large degree, due to the availability of polythene. In 1940 an entirely new plant was designed; it was completed by the end of 1941 and got into production in 1942. The experience gained was put at the disposal of the United States, and large plant began operations there in 1943. Further development of polythene production in the U.K. is in hand and in 1950 the capacity should exceed 10,000 tons a year. In the latest plants now being erected, the ethylene from which the polymer is prepared will be derived not from alcohol but from crude petroleum.

Polyvinyl chloride. Polyvinyl chloride itself as a chemical compound had been known for about 50 years before it was discovered how to produce a commercial plastic from it. British chemical interest was first seriously aroused in it early in 1939, by which time plastics based on it were being sold both in Germany and in the U.S.A. After the outbreak of war, those working here on the product foresaw a possible large use for it as a substitute for rubber in certain specialized applications, if by accident of war the supplies of rubber from the East were cut off. Plans were accordingly laid, first, for small-scale production, and then for manufacture in a large Government plant. By 1941 the U.K. production capacity for polyvinyl chloride polymer was about 500 tons a year, and most of the applications that are of commercial importance to-day had been studied on a small scale. By 1944 a Government plant, with an annual capacity of 5,000 tons, had been erected and was in operation. To meet increasing demands, the industry has raised its annual productive capacity to 18,000 tons.

Synthetic Fibres. While " man-made " fibres are generally considered to fall outside the scope of the chemical and plastics industry, yet they are obviously bound up with them, since progress in this field stimulates interest and research in the plastics industry, for chemically the materials that go to make up the fibres are often suitable for plastics manufacture.

Besides the cellulosic fibres or rayons, there has been some development of fibres based on protein. On the Continent casein was almost entirely used, but both here and in the United States experimental work has been done with the proteins of soya bean, ground-nut and maize.

In Britain most of the investigation was concerned with the production of a fibre from ground-nut protein. The meal from the nut, after being freed from oil by low-temperature extraction, was treated with dilute alkali to separate the protein. This was precipitated with sulphur dioxide and dissolved in a stronger alkaline solution to yield material that could be spun after coagulation by extrusion into an acid bath. The fibres so formed are hardened in formaldehyde, washed and dried. They produce a material that is soft, warm and more like wood than any other " man-made " fibre. In 1946 a pioneer plant came into use, and a large-scale manufacturing unit is in course of construction.

In discussing plastics it has been necessary to refer in some detail to the nylons because of their chemical nature; from the user's point of view they fall rather into the present subsection. Their development called for major advances in chemical processes as well as for an entirely new spinning or extrusion technique, because the fibres are produced from molten polymers. From what has been said in the last subsection, it is clear that the nylons depend for their raw materials on a number of organic chemical syntheses, most of them entirely new to the industry, and some of them conducted on a very large scale indeed.

The first nylon-spinning unit in this country began operations in 1940 under licence from the United States, and operated on imported material until in 1942 a British plant began to make the polymers. Expansion in output followed, and production reached about 1,000,000 lb. of yarn per annum. This was used entirely for Service requirements, in place of silk, proving invaluable for man-carrying parachute fabric and for various forms of cordage, including tow-ropes for submarines and gliders. At the present time there is an established outlet for nylon in women's stockings and a wide range of other products, such as dress fabrics and knitwear, and also cordage and canvases, for which the outstanding properties of the fibre more than outweigh its relatively high price.

A large-scale plant, having an output of 10,000,000 lb. per annum, will be in operation this year. Compared with the current output of rayon and the immense consumption of cotton and wool, this total is still small. On the other hand, the production of 5,000 tons of polymer calls for large chemical plant and considerable capital outlay.

There are other fibres being produced in this country on pilot-plant scale; they include " Terylene," which is a polyester fibre made from terephthalic acid and ethylene glycol, and was discovered in this country. The fibre is of considerable strength, having as outstanding properties its excellent resistance to degradation by sunlight and a high modulus at low loads.

Small-scale production in Britain of mono-filaments from polyvinyl chloride and polyvinylidene chloride was announced in 1948. The second of these, equivalent to the American product " Saran," is mainly used in the U.S.A. for vehicle upholstery and insect screens.

Besides the above fibres and filaments, which are either in full-scale or pilot-plant production, many others are at present the subject of research, and the development of man-made fibres, especially those based on strictly synthetic material, is considered by many to be only in its infancy. " Orlon," made from acrylonitrile, and " Vinyon N," an interpolymer of vinyl chloride and acrylonitrile, are being developed in the United States. There will doubtless be many others.

It is strange that in this discussion no mention of future production figures for polystyrene are included, for as we have often related in this journal its proposed production is of outstanding importance, and one of the aims of the new " chemicals from petroleum " industry is its manufacture in bulk. Presumably, also, such production figures have been omitted in the analysis of " The Summary of the Forward Plans " table.

The remainder of the report forms frank and enlightening discussion on Patents and Monopoly, including competition, price restrictions and limitation of output, Location of Factories, Staff and Labour Relations, Productive Efficiency, etc.

In welcoming this remarkably important report we stress again the importance of propagating the knowledge contained therein, not only to show the delicately balanced structure and importance of the industry, but more especially the value of chemical research and chemical control in making it attain an efficiency unsurpassed by any other.

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Fig. 1.—Ash trays, caskets and figures as cast in pigmented "Marco" resin mixtures using flexible moulds.

Low Pressure Resins

By BRIAN PARKYN

Some Notes on the Modern Development and Applications of "Marco" Resins

ONE of the most important of landmarks in the growth of the plastics industry, commensurate in a sense with the advent of any of the older series of thermoplastic or thermosetting resins, was the production of the first unsaturated polyester resin C.R.39 in 1942, for it introduced the very highly desirable property of being mouldable or otherwise formed at very low pressure. C.R.39, allyl diglycol carbonate, was undoubtedly a product of the research conducted on alkyd resins which figures so predominantly to-day as a resin for paints, the earliest type having been produced from glycerol and phthalic acid or anhydride. The range of similar resins now available, and of which the "Marco"* resins form a group, is both considerable and finding important applications in industry.

The unsaturated polyesters may be considered as hybrid resins, forming in a manner similar to the polymerization of vinyl or acrylic types evolving no by-product and necessitating in common with the aforesaid monomers the presence of peroxide catalysts to initiate the reaction. Unlike these, but resembling the phenolic and urea resins in one respect, they form a cross-linked thermosetting structure.

It is clear that a resin having these characteristics will require little or no pressure when used for moulding and laminating, and for this reason unsaturated polyester resins have become widely known as "low-pressure resins."

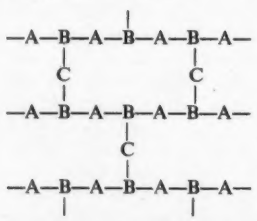
Unsaturated polyesters are formed by the esterification of hydroxy compounds with polycarboxylic acids, the resulting syrups being copolymerized with unsaturated monomers in the presence of peroxide catalysts. At least three classes of compounds are therefore necessary for their manufacture.

A. Alcohols. Either saturated dihydric alcohols such as the glycols and polyglycols, or unsaturated monohydric alcohols such as allyl alcohol.

B. Acids. Polybasic saturated or unsaturated acids such as phthalic, succinic, fumaric, maleic and itaconic acid or their anhydrides.

C. Polymerizable compounds such as methyl methacrylate, styrene, diallyl phthalate and cyclopentadiene.

The polyester prepared by the condensation of acids and alcohols from groups A and B above, must contain at least one unsaturated component. In some cases an unsaturated alcohol is reacted with a saturated acid. In other cases a saturated alcohol is reacted with an unsaturated acid. The reactive double bonds resulting from the unsaturated component of the alkyd resin chain make it possible to achieve a cross-linked structure, when the resin is polymerized with one of the monomers from group C. This can be represented by the following simplified diagram:



In this example, "A" represents a saturated dihydric alcohol; "B" an unsaturated dicarboxylic acid; and "C" the cross-linking monomer.

* Developed in the U.S.A. by Marco Chemicals, Ltd., and now being manufactured in the U.K. by Scott Bader and Co., Wollaston, Northants.

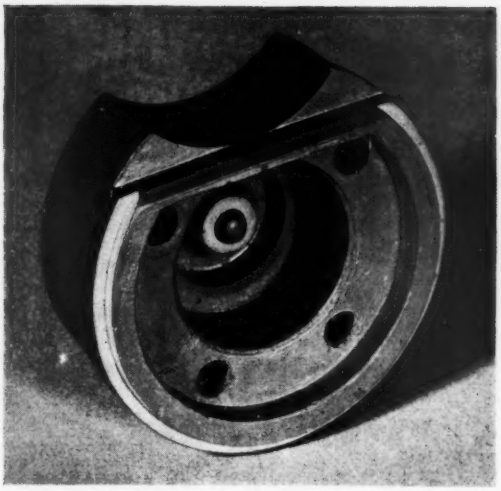


Fig. 2.—Distributor casing, with brass inserts, transfer moulded at low pressure from a stiff dough.

The molecular structure of an unsaturated polyester resin such as this can be easily modified, so that polymers having very different physical properties result. For instance, the greater the space separating the chain bridges "$\begin{matrix}|\\B\\|\end{matrix} - C - \begin{matrix}|\\B\\|\end{matrix}$" the more flexible will be the final product. This can be achieved either by using a higher glycol (A), or by introducing a saturated dibasic acid, such as succinic or adipic acid, into the alkyd chain. If this be represented by "D," the molecular structure of the resin syrup will become:

$$\begin{matrix}-A-B-A-D-A-B-A-\\ \quad\ |\qquad\qquad\ |\end{matrix}$$

The cross-linking bridges are farther apart in this example, resulting in a product, when fully polymerized, of considerably greater flexibility.

It is hoped that this short summary of the chemistry of unsaturated polyester resins will be sufficient to demonstrate the enormous variety and versatility of the resins which can be encountered in this very new field of synthetic plastics.

Low-pressure Laminates

By far the most important use for the unsaturated polyester resin is the manufacture of laminates reinforced with either glass-cloth or glass-fibre mat. On account of the non-absorbent nature of the ultimate glass-fibre, extremely low pressures (compared with phenolic/paper laminates, for instance) must be used. Laminating pressures rarely exceed 14.4 lb./sq. in., and they are often considerably lower, so that the technique is frequently called "Contact" or "Zero Pressure" laminating.

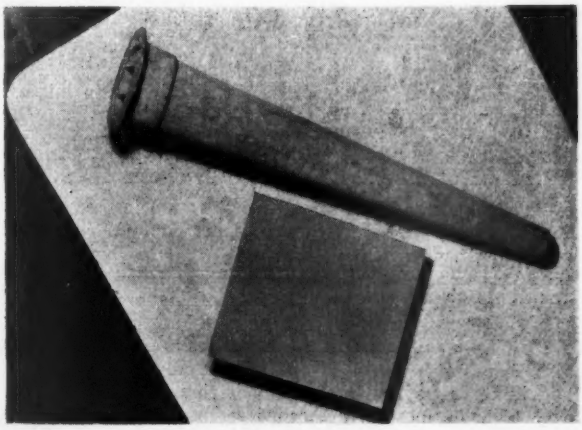


Fig. 5.—Glass mat laminate, flat glass-cloth laminate, and glass-cloth laminate aerial shield, for use on aircraft.

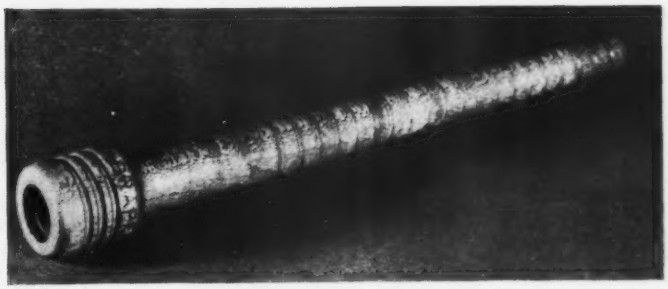


Fig. 3.—Wooden textile bobbin, vacuum impregnated with "Marco" resin.

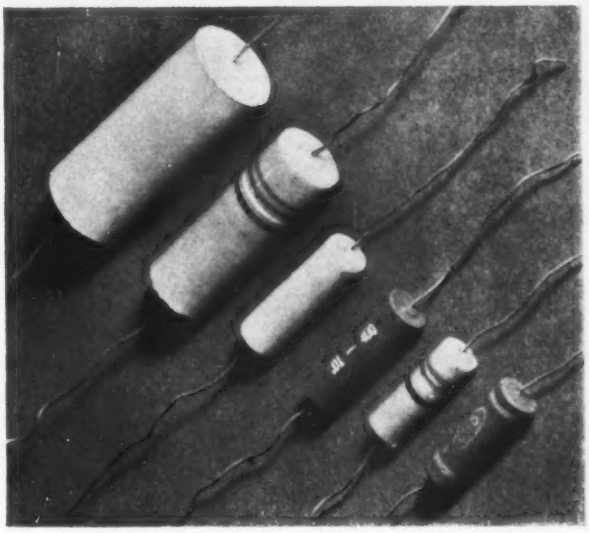


Fig. 4.—Each of these tubular condensers has been vacuum impregnated and also encased in "Marco" resin.

Up to the present, most moulded low-pressure laminates have been produced by the flexible bag technique, a process well known in the plywood industry. The resin-impregnated glass-cloth is carefully built up on a rig form, either male or female, and the laminating pressure supplied by an inflated or deflated rubber bag which is made to cover or fill the mould exactly. The resin is either cured thermally, by running the assembly into an oven of about 120 degrees C., or cured at room temperature. In the latter case a cold setting Marco resin mixture is used which will normally cure in 2 to 3 hours.

There is often some uncertainty on the part of low-pressure laminators, as to which of these two methods of cure is preferable. Both have certain advantages, making either one or the other more suitable, according to the particular article being laminated. The cold setting process has two main advantages: 1. It is obviously the only convenient method for laminating very large structures such as boat hulls; 2. Laminates produced by this process have better mechanical properties. This is on account of the lowering of the resin viscosity during thermal cure, enabling much of the resin to run away. The main disadvantages are that it is slower than the thermal process, and it also necessitates using a resin mixture of very short shelf-life. This may allow insufficient time to lay up a laminate having a complicated shape.

Fig. 6 (below).—Models for anatomical study are cast in ivory-white mixtures of "Marco" resin.

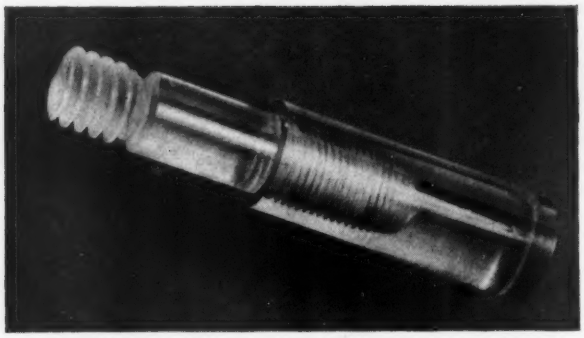


Fig. 7.—This clear rod, cast in a lead mould, with threads turned on a lathe, shows the good machining properties of the cast resin.

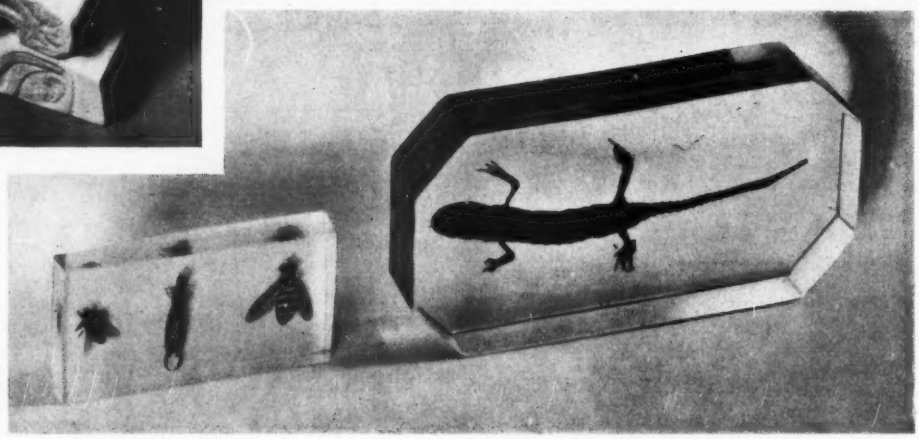


Fig. 8 (right).—Cold-setting "Marco" resin provides a useful embedding medium for insect and like specimens.

Low-pressure laminates are being increasingly used in industry to-day. Their remarkable mechanical strength (glass-cloth laminates have been made with an ultimate tensile strength of nearly 100,000 lb./sq. inch), coupled with a specific gravity of about 2, results in a strength/weight ratio which is surpassed by few other materials. Fatigue caused by mechanical vibration is low, and the laminates are transparent to radar frequencies. These properties have stimulated much development work by aircraft companies, who already use these resins for laminating radomes, hot air ducting, and certain internal panelling.

Electrical Applications

The unsaturated polyester resin finds its next most important use in the electrical industry. This is not surprising, since a thermosetting resin which cures without evolving moisture can be expected to have interesting electrical characteristics. Tubular condensers and rotor windings are vacuum impregnated, in the former case to make them impervious to humidity, and in the latter case to improve the overall insulation of the windings. In some cases the entire condenser is also encased in Marco resin. This can be either compression moulded from a resin dough or cast by using a cold-setting resin mixture. The latter technique is also used for embedding or "potting" delicate radio components, to protect them from mechanical shock.

In high-voltage applications, these resins have been found valuable for their excellent tracking resistance. Transformer and choke windings are impregnated and encased; panels and components for switchgear moulded; and high-tension cable junctions cast in the field.

Other Applications

Marco resin has been found useful in many other industries. As a cold-setting syrup it is used in various casting applications using either lead or flexible moulds. In this connection "Welvic" P.V.C. paste, manufactured by I.C.I., Ltd., is particularly useful. When the resin is heavily filled with slate dust or silica flour, low-pressure transfer moulding is possible. Aluminium or other cheap tools are used, making it economic to mould a relatively short run of units.

The impregnation of wooden articles "in vacuo," for instance, textile bobbins, considerably increases dimensional stability and impact strength. Even the British Museum has found this resin useful. Prehistoric remains, such as bones, have been vacuum impregnated in order to preserve them for all time from decay. They have also pioneered the technique of embedding zoological and anatomical specimens in a clear block of resin. This greatly facilitates the handling and display of fragile exhibits, and is of particular value in schools.

Medical research workers use a self-setting resin mixture for making casts of internal human and animal organs. The pigmented mixture is injected into a lung, kidney or intestine section for example, and allowed to harden, the fleshy tissue being subsequently dissolved away. Perfect pathological exhibits have been made by this process, showing remarkable detail. Even capillaries of microscopic size when replaced by resin remain intact.

It can be seen from this very brief résumé how wide and varied already are the present uses of low-pressure resins. They differ so greatly from the more well-known raw materials of the plastics industry that entirely new techniques have often to be developed. They do not replace the earlier materials, but rather supplement them, each having its own particular fields of application. Whether it is being used in components for the most modern jet aircraft or for preserving some prehistoric specimen for a museum, the low-pressure resin has found a place in industry, and has come to stay.

World's Industry Employs Plastics

GENERAL ENGINEERING

Transparent storage trays.—Visibility and compact storage are combined in transparent plastic storage trays for small parts. Trays are in two sizes and fitted with four removable partitions. ("Factory," 1949/Nov./152.)

Machining laminated plastics.—W. Nichols discusses the various operations in machining plastic laminates, including punching of holes. ("Machinery Lloyd," 1949/Nov. 26/63.)

Materials handling in plastic processing.—J. A. Lea describes the modern equipment in the new Bakelite plant at Ottawa, Ill., and the safety precautions for the operators. ("Chem. Engineering" (N.Y.), 1949/Aug./100.)

Strength of sandwich panels.—The effect of shear deformation of the core of a flat rectangular sandwich panel was investigated in two groups of problems. The reduction of the compression buckling load of rectangular panels subject to each of four edge conditions; the increase in the central deflection of rectangular panels under uniform transverse loads and subject to the conditions that all edges are simply supported or that they are all clamped. (U.S. Forest Products Lab., Madison, Wis., Progress Report, May/1948.)

Radio-frequency welding of plastics.—After brief reference to the welding of thermoplastics by heated tools and hot gas methods, the advantages of the radio-frequency process are explained. The thermal conduction of the welding electrodes profoundly modifies the power requirements from the associated high-frequency generator when material thickness is small. ("Journ. Brit. Inst. Radio Engs.," 1949/Sept./322.)

Laboratory tests on "Araldite."—M. Ros reports on extensive tests on this thermosetting resin, in particular tensile shear tests and bending shear tests. Results are also given of a new type of test to measure the resistance of bonds to peeling flexure. ("Sheet Metal Industries," 1949/Sept./1967.)

Mould Hobbing.—Recent American practice is revealed in an instructive article by J. Thomas and E. W. Spitzig dealing with the selection of hobs, hobbing blanks, hobbing rings and hobbing operations. ("Tool Engineer," 1949/Dec./26.)

Mould finishing.—M. C. Overholt in a paper read before the American Society of Tool Engineers recommended up-to-date methods for the finishing of plastic moulds. Amongst others referred to is liquid honing. ("Tool Engineer," 1949/Dec./28.)

Injection moulding.—Messrs. O. and M. Kleemann, Ltd., in their plant at Aycliffe, Durham, use a large number of Reed - Prentice injection moulding machines of 8-oz. capacity. A number of parts and moulds are described. ("Machine Tool Review," 1949/Sept.-Oct./109.)

MISCELLANEOUS

Polyamides as plastic raw materials.—In a series of articles A. Mueller is to discuss the most important fields of application and the working methods of these materials. The first instalment deals with polyamide foils produced by casting, blowing and melting. ("Kunststoffe," 1949/Dec./313.)

Nylon under stress.—J. Miklowitz investigated the initiation and propagation of the plastic zone along a tension specimen of nylon, discussing the effect of the speed of loading, rigidity of testing machine, etc. In a further paper he deals with the stress-strain relationship of nylon under biaxial-stress conditions, comparing them with results of the simple tension test. ("Journ. Coll. Science," 1949/Feb./193.)

Swelling of laminated Plastics.—An investigation by F. T. Barwell and K. W. Pepper shows that by proper selection of materials and manufacturing conditions it is possible to reduce considerably the extent and effect of water. ("Brit. Science New," 1949/Oct./357.)

Polyvinyl chloride in the chemical industry.—K. Klostermann reviews the use of hard p.v.c. material in the chemical industry dealing with production, properties, and working methods. ("Chemische Rundschau," Solothurn, 1949/No. 15/1.)

Fast-curing phenolic plastics.—Two materials, recently developed by Rogers Corp., Manchester, Conn., can be easily poured or automatically preformed. They can be compression, transfer or plunger moulded for medium to high impact characteristics under moulding pressures of 4,000 to 6,000 lb./sq. in. Compression strength is 25,000 lb./sq. in. and tensile strength 5,500 lb./sq. in. ("Product Engineering," 1949/Sep./169.)

Polyisobutyene and polyvinyl ether as glues are reviewed by H. Hadert. ("Farbe und Lack," Hanover/1949/No. 8/275.)

External design in moulded plastics are discussed, with the aid of numerous examples, by D. W. Birklen. It is, for instance, shown how flash lines can be utilized as a line of rhythm in the design. ("Product Engineering," 1949/Sep./146.)

A new corrosion test for plastics is described by W. H. Adams and H. H. Lebach. ("Chemical Engineering" (N.Y.), 1949/July/98.)

Tensile properties of films.—L. Boor found that in the evaluation of plastic and elastomeric films the measurement of tensile strength and elongation by conventional methods is not adequate. He considers that the whole pattern of stress-strain relationships from zero load to final fracture is necessary. ("A.S.T.M. Bulletin," 1949/Dec./47.)

Ignition and burning characteristics of plastics.—H. J. Stark reports on tests made with melamine, phenolic and polyester resins, and compares them with data on flash and self-ignition temperatures. ("A.S.T.M. Bulletin," 1949/Dec./55.)

Strength of thermosetting resins.—C. O. Grimm reports on tests made for the Swiss Commission for Material Testing to obtain data on the production of test samples from moulded thermosetting resins. The conclusion was drawn that a strict prescription of moulding temperature, pressure and time is not essential, and reasonable limits are possible. ("Schweizer Archiv. angew. Wiss. and Technik," 1949/Aug./248.)

New uses for Teflon.—Recently six new uses of Du Pont's tetrafluoroethylene plastic have been made known: (1) as an industrial finish, spray applied; (2) an enamel for wire used in motors and electrical devices; (3) an extruded coating for heavy wire; (4) an unsupported film of better quality and thinner gauge than previously; (5) coating for glass fabrics; (6) a chemical tank lining. The material is applied by spraying. ("Chemical Engineering," 1949/Nov./120.)

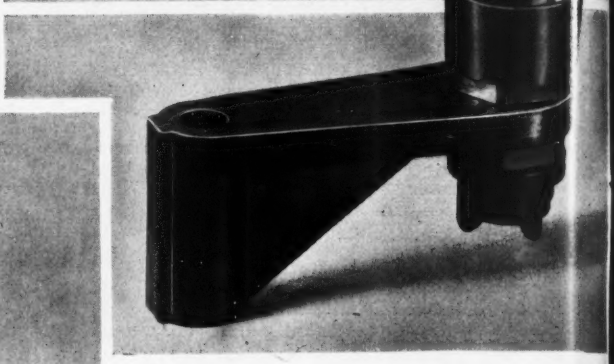
Preshrinking polyethylene fabric by a new finishing treatment may remove the last barrier to its widespread use as fabric. Fabric is first treated in semi-relaxed state with hot water, hot air or steam. After shrinkage the fabric is steamed on a decating machine to increase uniformity and flexibility. ("Textile World," 1949/Nov./145.)

The nature of adhesion.—S. Moses analyses data on the adhesion of polystyrene and methyl-methacrylate systems to aluminium alloys Adhesion seems to depend on the presence of a fluid, or quasi fluid or mobile state at or near the film-metal interface. ("Ind. Eng. Chemistry," 1949/Oct./2338.)

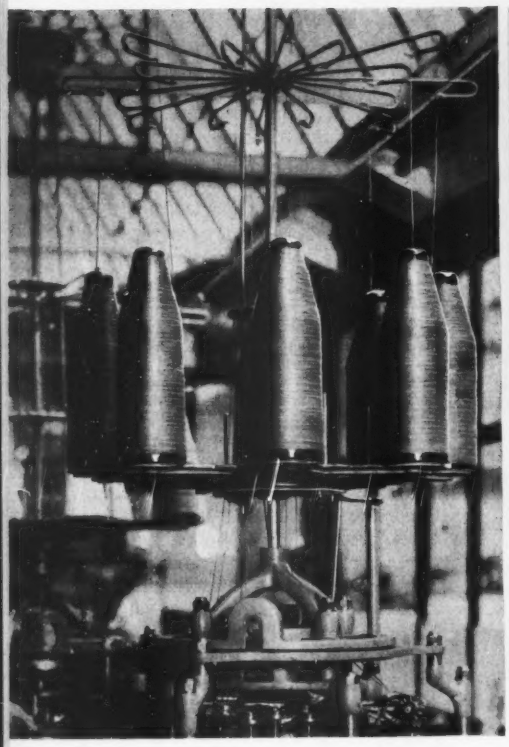
PLASTICS
IN THE SERVICE OF MAN

A pictorial review of high-quality units moulded or otherwise fabricated in Great Britain . . .

8. Textile Machinery.

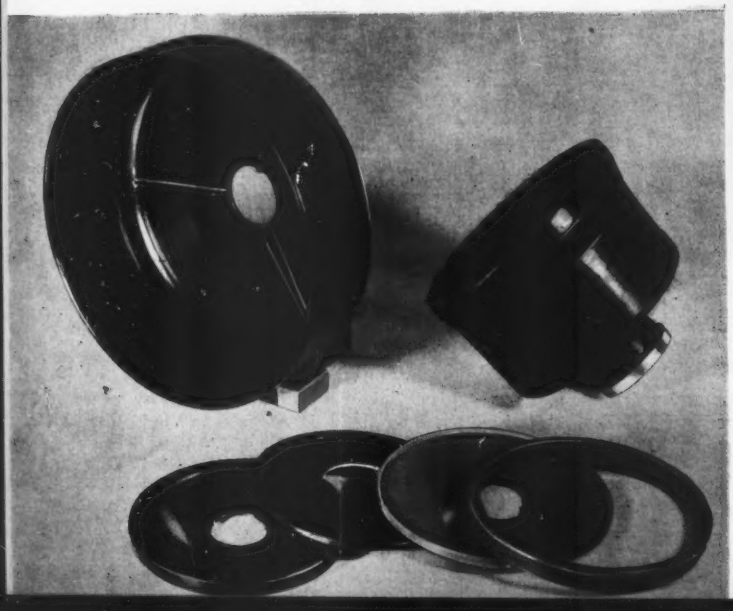


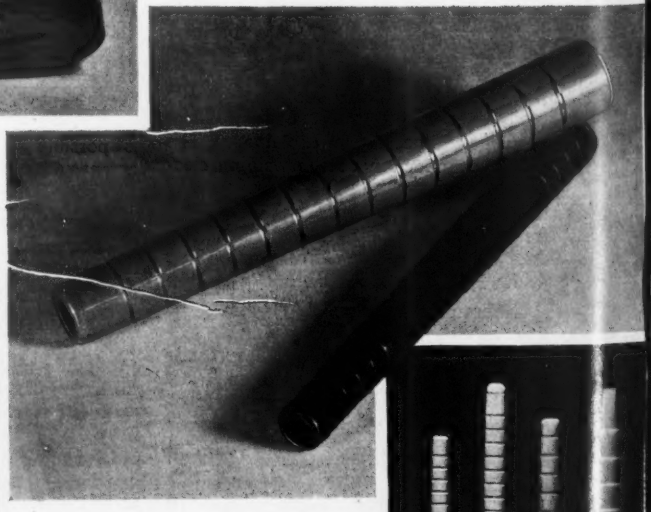
(Above) Bracket, funnel holder, securing ring and lock-nut—all phenolic mouldings—form the assembled unit shown, which is used in the manufacture of rayon fibres. Mouldings by Universal Metal Products, Ltd.

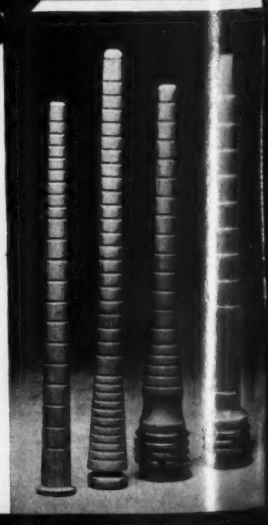


(Left) Two phenolic parts made by Kent Mouldings form the large bobbin which is used on this knitting machine made by I. L. Berridge and Co., Ltd.

(Below) Large spinning box lid, spinning pot with brass insert, and spinning pot lids for use in rayon spinning, are moulded from phenolic materials by Ashdowns, Ltd. Fabric laminate is used for the ring and lid shown at the lower right-hand corner.

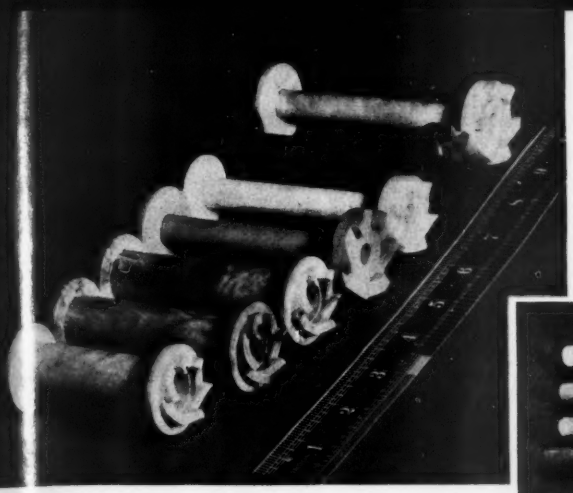




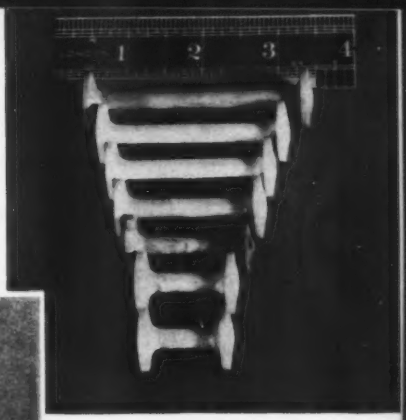


(Above and right) These plastic pirns, injection moulded by Alfa Plastics, Ltd., show the great variety in details of design which is common in the textile industry.

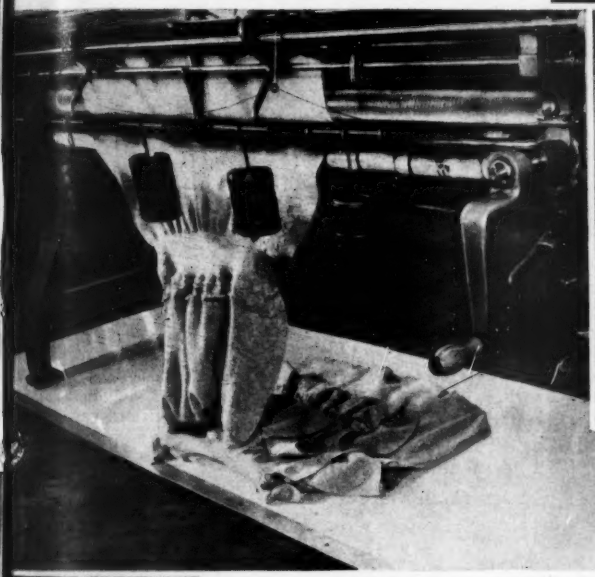
(Below) Quill or pirn tubes, plain and grooved, moulded from thermoplastic materials in various colours by Plasticast Developments, Ltd.

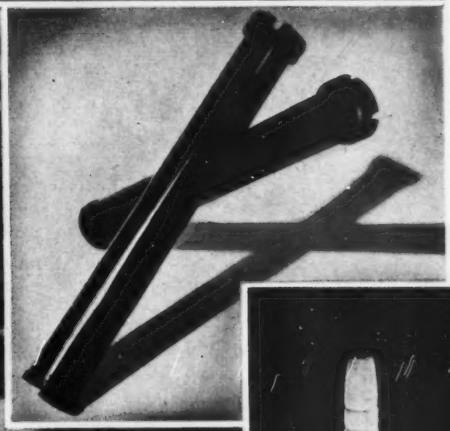


(Above) These injection moulded braider bobbins, made by Plasticast Developments, Ltd., are provided with ratchet teeth as part of the moulding.

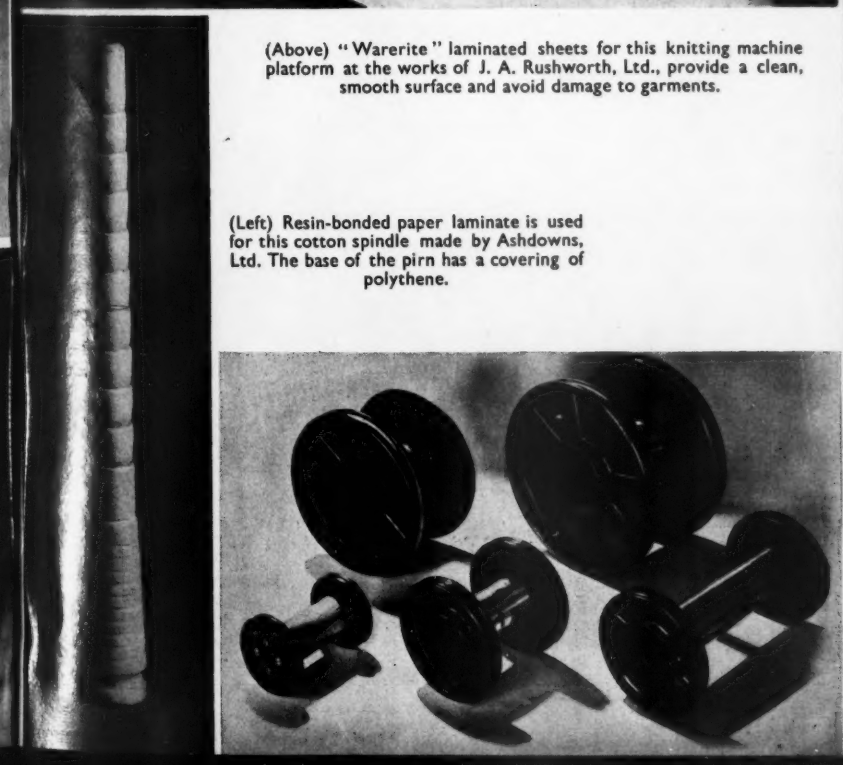


(Above) Bobbins for use in the narrow fabric industry are made from thermoplastic materials by Plasticast Developments, Ltd.

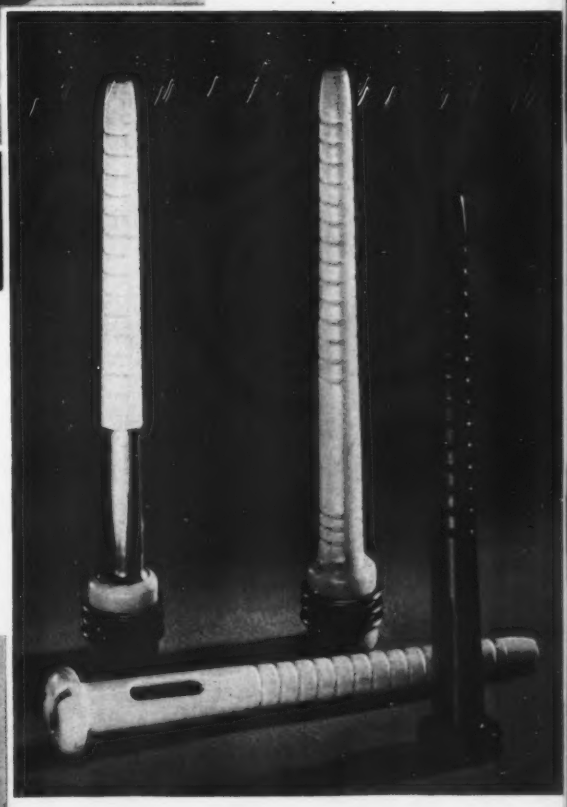




(Left) The barrel of these 10-in. lift bobbins is "Rockite" shock-resisting phenolic extrusion. The castellated end ring is "Cellomold" cellulose acetate and is attached to the barrel in one special injection moulding operation. Made by Lumb Hall Engineering Co., Ltd., from materials supplied by British Resin Products, Ltd.



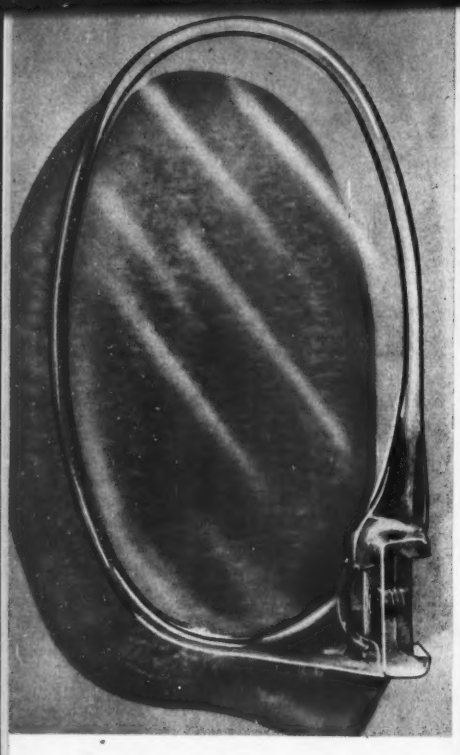
(Above) "Warerite" laminated sheets for this knitting machine platform at the works of J. A. Rushworth, Ltd., provide a clean, smooth surface and avoid damage to garments.



(Above) These plastic pirns made by Stabel Products, Ltd., offer great advantages in uniformity, smoothness and durability.

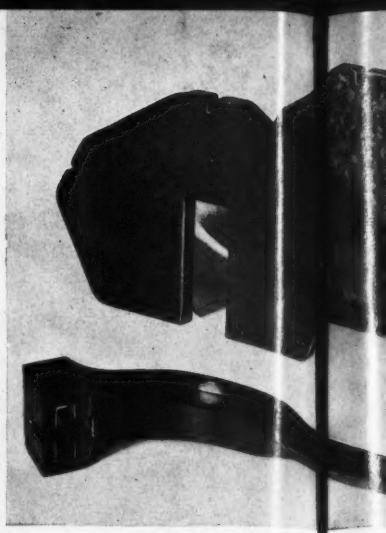
(Left) Resin-bonded paper laminate is used for this cotton spindle made by Ashdowns, Ltd. The base of the pirn has a covering of polythene.

(Left) These bobbins and selvidge beams manufactured by Stabel Products, Ltd., combine phenolic mouldings with light-alloy barrels.

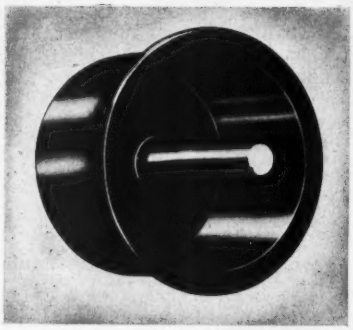


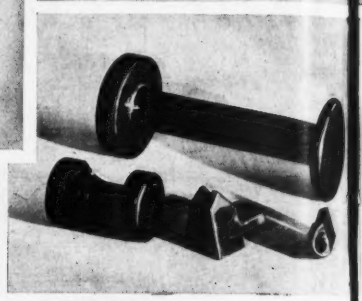
(Above) Blinker separator, moulded from transparent "Diakon" acrylic powder (I.C.I.), for Platt Bros. and Co., Ltd., by Lorival Plastics.

(Left) The white cellulose acetate yarn guides as well as the compression-moulded front condenser and back condenser are made by Universal Metal Products, Ltd., for use in high-drafting machinery.



(Right) Tensioning pulley for an uptwisting silk-winding machine, moulded in phenolic, with steel spindle insert. Made for S. and E. Scragg, Ltd., by Lorival Plastics.





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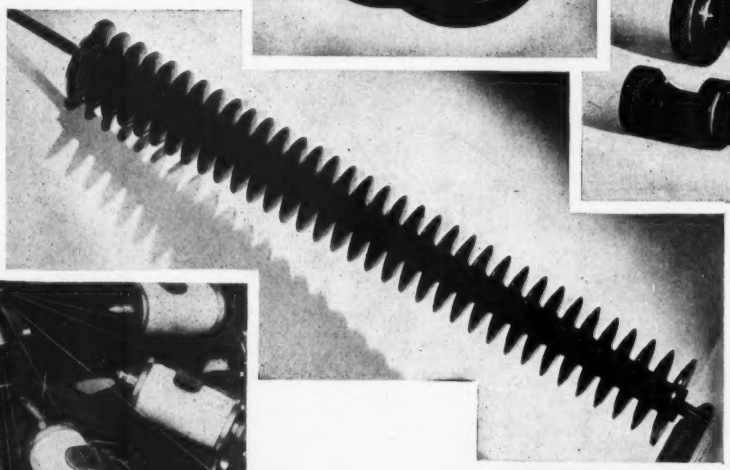
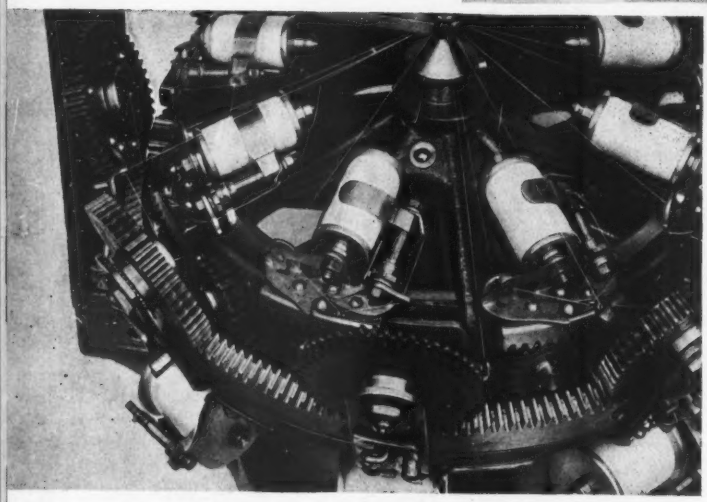


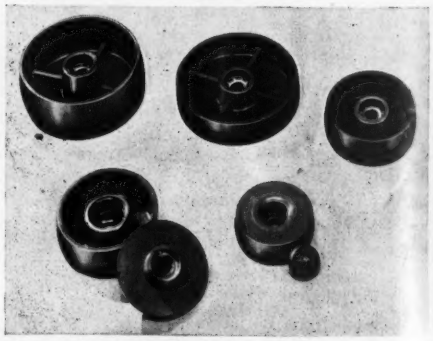
(Right) Shuttle of "Permali" high-density wood laminate, made by New Insulation Co., Ltd.

(Left) This 4-ft. textile dividing roller is made by Thomas Waring and Sons, Ltd., from a series of "Bakelite" mouldings mounted on a steel shaft.

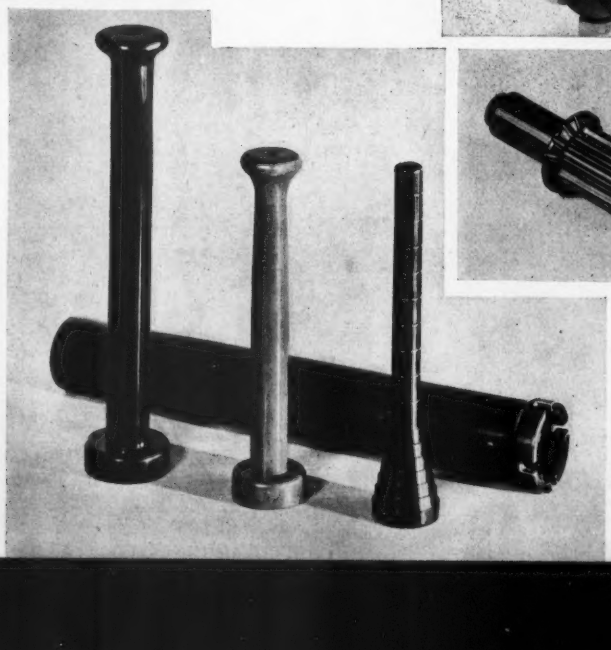


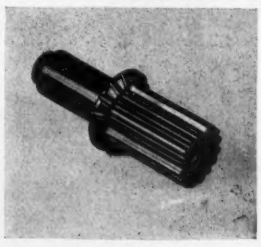
(Above) "Permali" high-density wood laminate, made by New Insulation Co., Ltd., provides silent gears, which require no lubrication, for this high-speed knitting machine.

(Right) Tape-tensioning pulleys, used on ring frames for cotton spinning are made for Skefko Ball Bearing Co., Ltd., and Platt Bros. and Co., Ltd., by Lorival Plastics in phenolic materials.



(Below) Cone mandrels, in semi-shock-resisting P.F. material, made by Lorival Plastics for Thomas Holt and Co., Ltd.





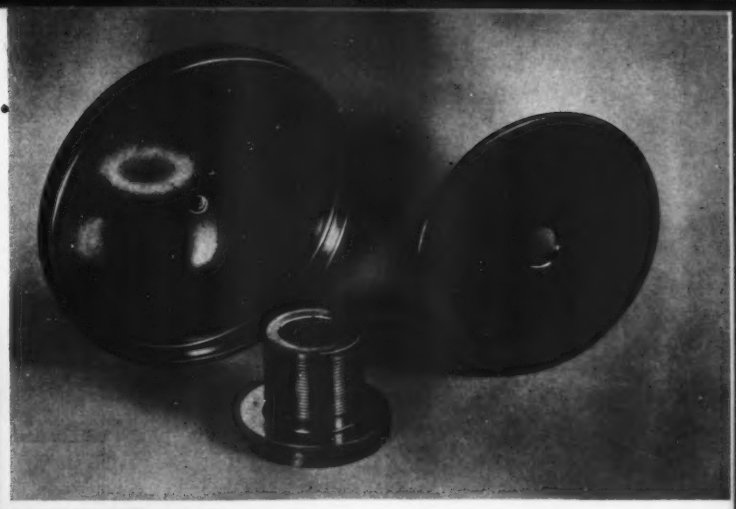
(Left) A two-step roller moulded in specially water-resisting material by Ashdown, Ltd.

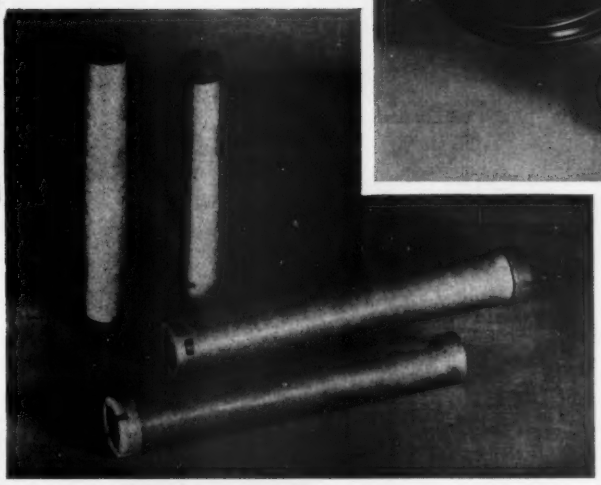
(Left) The card-room bobbin (1½ in. doubling bobbins and pirn among phenolic accessories for the cotton industry, moulded by Robert McArd and Co., Ltd.

(Right) The 4-ft. in. slay boat sticks and shuttles are made of densified wood laminates by Components (Jablo), Ltd.

(Left) Sliding plate and fixed plate in alkali-resistant, shock-resistant phenolic material, and acid-resisting thread guide holder, moulded by Ashdowns, Ltd.

(Right) Winding lid, spin pot lid and filter nut, compression-moulded in phenolic by Universal Metal Products, Ltd., for rayon-spinning machinery.





(Left) Three plastic materials are used by Engineering and Allied Manufacturing Co., Ltd., to make these "Enalon" bobbins for the cotton-spinning industry. The body is resin-bonded paper laminate, the castellated ring is coloured "Alkathene," and the bushing is a urea or phenolic compression moulding.

(Left) Lappet holder, thread guides and bobbin in different coloured phenolic materials, moulded for the textile industry by Birkbys, Ltd.

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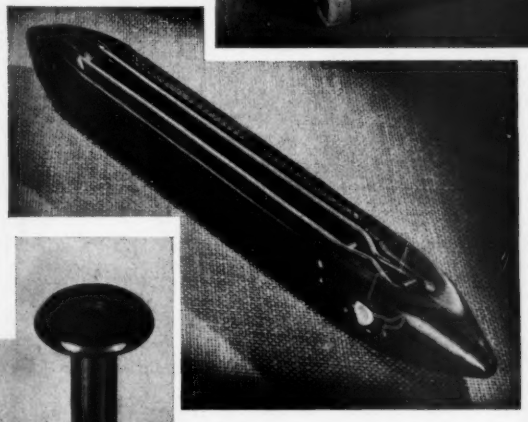
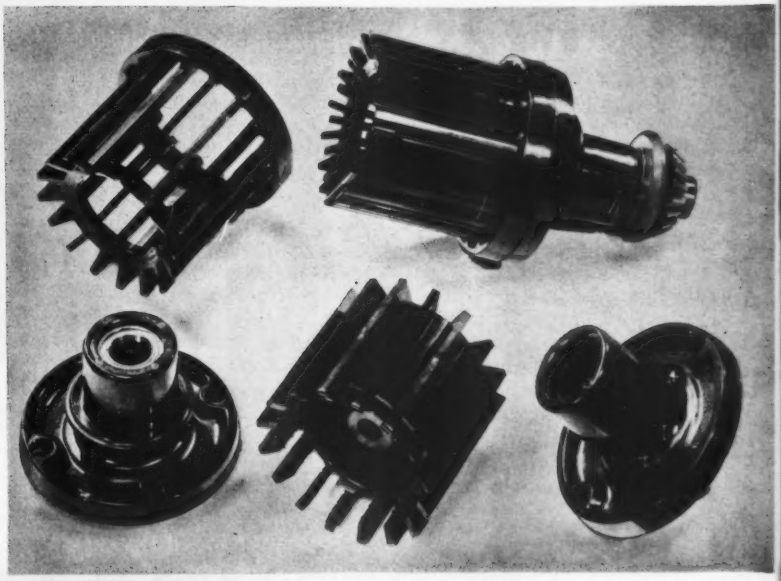
textile dividing de by Thomas ons, Ltd. from a elite" mouldings a steel haft.





(Left) Coloured "Bakelite" bobbins, made by Kent Mouldings, are found to have advantages over wooden bobbins in the flax- and jute-spinning industries.

(Above) Chemical-resistant nylon-filled "Bakelite" is used by Courtaulds, Ltd., to mould these thread-advancing reels.

(Below) Rotary traverse roller used in some high-speed winding machines, moulded in phenolic by Lorival Plastics for Arundel Coulthard and Co., Ltd.

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Thermoplastics for Temporary Mechanical Protection of Materials and Equipment—II

By E. E. HALLS

THE American use of thermoplastic solutions for mechanical protection was a logical extension of the war-time development of plastic packaging. The material employed has the trade designation of "liquid envelope," and it was developed by Better Finishes and Coatings Inc., Newark, New Jersey, U.S.A. It is described as a modified vinyl polymer of complex formulation, plasticizers and adhesives in a volatile vehicle, yielding an applied film which possesses a unique combination of physical properties. The coating is tough, elastic, impervious, transparent or opaque, sticking with any desired degree of adhesion and yet capable of being peeled off in sheet form without effort from the surface to which it is applied.

In its original applications, it must be remembered that a primary objective was the hermetic sealing of components and equipment against the ingress of moisture, and therefore the composition was formulated to give the lowest possible value for permeability to moisture vapour. This property is not required in all the applications of the present subject. The full range of properties quoted by the American manufacturer for "liquid envelope" is as follows:—

Film strength: Up to 2,000 lb./sq. in.

Elongation: Up to 200 per cent., according to purpose for which formulated. (Elasticity is the same in all directions and the material returns to its original dimensions after elongation within its elastic limit.)

Transmission of moisture vapour: This varies inversely as flexibility and ranges from 0.25 to 3.0 gm. of water vapour per 100 sq. ft. per 24 hours.

Water content: Below 0.25 per cent

Thickness of applied film: From 0.005 in. to 0.050 in., dependent upon grade of material and nature of application.

Resistance to solvents, etc.: Excellent resistance to petrol, oils, fats, greases, acids, alkalis, salt spray and alcohol.

Effect of heat: Dependent upon formulation; not tacky below 180 degrees F. (82 degrees C.); melting point above 250 degrees F. (125 degrees C.).

Flame resistance: Non-inflammable (in film form) for all film formulations designed to retain flexibility above 0 degrees F. (−18 degrees C.).

General characteristics: Odourless, tasteless and neutral.

Pigmentation: Transparent, or opaque forms in any colour shade.

Effect on finish: Will not bleed an underlying finish or transfer.

Adhesion: Satisfactory adhesion and stripability from 0 degrees F. (−18 degrees C.) to 200 degrees F. (93 degrees C.). Degree of adhesion can be varied to suit specific purposes.

Drying time: Can be adjusted within limits to suit needs. Average drying time is 10 mins. at 70 degrees F. (20 degrees C.) and 60 per cent. humidity in free air; this can be reduced to as little as 2 mins. by forced drying at temperatures up to 250 degrees F. (125 degrees C.).

Application: Formulations to suit hot or cold spray, hot or cold dip, and brush processes.

Durability: Protection for storage up to 25 years.

These properties require no further explanation; nevertheless, attention is drawn particularly to strength, elasticity, heat and solvent resistance and durability of the film, and to flexibility with respect to the range of grades possible, manipulability in application, and ease of removal.

One of the earliest and most successful applications of "liquid envelope" was the wrapping of complete aircraft, ready for operation, as deck cargo to the Pacific theatre of war. Ordnance was similarly treated. Further, war equipment for storage for 10 years, often in open-weather

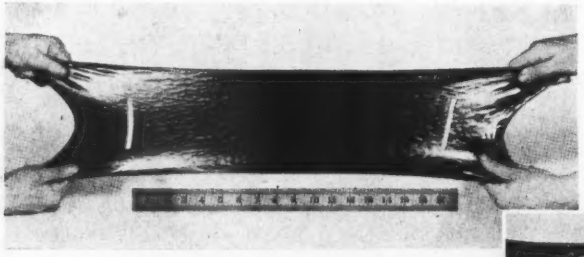
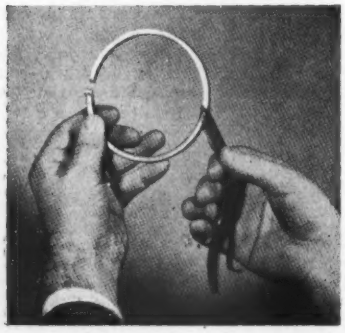


Fig. 1.—These photographs show a strip of "liquid envelope" elongated to 17 ins. between marks (above) returning to its original dimension of 10 ins. between marks (right).



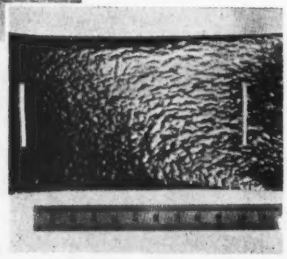


Fig. 2 (left) and Fig. 3 (right).—The ease of removal of "liquid envelope" coatings is demonstrated by these examples.

(Photos: Courtesy, Better Finishes and Coatings, Inc., Newark, N.J.)

conditions, has been packed by this method. For protection against damage in manufacture, handling, storage and transport, the method has been extensively applied, the following being outstanding examples:—

Stainless-steel sheets, prior to pressing into hospital and kitchen equipment; surgical instruments; automobile parts; electrical equipment; bottles containing deliquescent chemicals; X-ray films; tools and engineering components; ornamental castings; finished goods, such as refrigerators, washers, radios, pianos, domestic and office furniture, and mirrors.

Fig. 1 shows "liquid envelope" film stretched 70 per cent. and returned to its original length. Figs. 2 and 3 show the ease with which the film can be stripped or peeled off as a complete skin.

For providing protection from deterioration under open-weather conditions, in addition to mechanical protection for handling, a thicker film is applied. However, as it is often advantageous to apply the mechanical protection to final assemblages which have protuberances and apertures, the technique employed is closely the same for both needs.

The basic stages of the process include (a) surface preparation, if necessary; (b) padding of sharp protuberances and taping, and/or (c) webbing; (d) actual application of protective film.

Regarding surface preparation, a "clean" surface is necessary for maximum efficiency, as it is in normal finishing processes. In the case of material in the form of sheet, strip, tube, rod or sections, purchased with special reference to surface appearances, this normally only entails the removal of loose dust and dirt and any oil or grease contamination. A simple "wipe-over" with a cloth soaked in solvent, or degreasing in trichlorethylene, is all that is entailed. Fabricated components, additionally, may require acid pickling. "Metal-finished" work (i.e., plated or enamelled) can be treated at the completion of these metal-finishing operations without additional surface preparation. Assembled equipment should only need the blowing off or sucking off of dirt and dust, and perhaps the removal of any oil from machine operations. In equipments completely ready to operate, lubrication may have been applied, but this is no objection, although general oiling would detract from the adhesive properties of the coating.

The padding of sharp protuberances only concerns large, finished equipment, and then more particularly if these protuberances extend beyond the overall contours and are liable to make it easily possible for the covering to be strained. The padding uses paper or cloth, held in position with adhesive tape. Taping comprises the fixing of adhesive tape, criss-cross fashion, with spacing of up to 8 or 10 ins. Such taping is usually applied only over wide apertures or deeply recessed areas; when these are not present, it can be omitted. On the other hand, with irregular assemblages, such as ordnance, sculptures, electrical equipment mounted on racks, and the like, these may be taped as the basis of an overall "apron" of sprayed plastic.

Over the taping, a web coat of the "liquid envelope" is applied, using the spray gun adjusted to give a fine spray, and with the gun held at a relatively long distance from the work. In this way the applied solution produces fibres or strings, which are floated into position and built up to form a filamentous structure very similar in appearance to a shroud of cotton sheeting or muslin.

The "liquid envelope" proper is next applied, using an orthodox type of gun and technique, and the coating is built up to the thickness desired. Apart from colour range, the "liquid envelope" is supplied in two types, one for hot and one for cold spray. The hot-spray method is used for large areas and for thick coatings. The material for this is a semi-solid, viscous, jelly-like solution of polyvinyl composition in a solvent. The pressure reservoir feeding the spray gun is maintained at a temperature of 160 degrees F., plus or minus 10 degrees F., in order to maintain a temperature of 150 degrees F. at the gun. The cold-spray process uses a less-concentrated solution, of normal viscosity, for spraying at room temperatures.

Fig. 4.—Application of "liquid envelope" for the protection of completely assembled aircraft: spraying the coating, after taping.

The spray technique utilized is a normal, slow, rhythmic cross-coating motion, with the gun 8 to 12 ins. from the work, and the fan of the gun set to give a band 6 to 8 ins. wide. A decorative or appearance finish is not usually required, so that a coating can be applied as heavy as possible without runs, keeping the edge wet ahead of the spray. Up to 0.020 in. of thickness per application is stated to be practicable.

When this technique is employed for the moisture-proof packaging of large equipment, after complete sealing, a small window is cut in the covering, a silica gel type of drier is inserted, and a window is sealed into the aperture. For this window, a moisture-proof transparent plastic material is used, which overlaps the hole, temporarily fixed with adhesive type, and then sprayed with "liquid envelope" to enclose the junction. The silica gel can be replaced from time to time as required by breaking and remaking the window seal.

Fig. 4 shows one extreme application of "liquid envelope" spray, i.e., the protection of assembled aircraft. The flexibility of the process is very apparent, particularly the manner in which it may be stopped at a thin film, or extended to a heavy, built-up coating.

A specific example of the use of "liquid envelope" for the complete protection of raw-material sheet through fabrication operations has been described by W. A. Phair under the title of "Plastic Coating Expedites Stainless Stamping Operations" ("Iron Age," May 15, 1947, pp. 47-51). This article concerns the development of the use of strippable plastic coating on stainless-steel sheets by the Eastern Stainless Steel Corporation of America. By its use on the initial raw material, although passing through stamping and deep-drawing operations, die and other marks on the surface are eliminated and finishing costs are thereby reduced. The coating serves in some manner, not so far clearly elucidated, as a die lubricating and is said to reduce the power effort required in drawing.

Many attempts have been made to provide a temporary mechanical protection to polished stainless-steel sheet stock for presswork, with indifferent success. The commonest procedure is to gum paper to the surface. Difficulties, however, are encountered in securing the right type of adhesion to withstand the handling of press stages, to ensure easy final removal, and to avoid interference with tool clearances, etc. In their researches on this problem, Eastern Stainless Steel

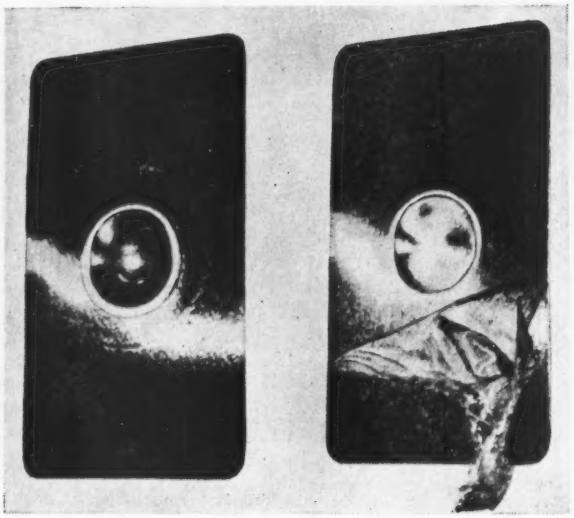


Fig. 5. — Erichsen cupping test, showing how the plastic film protects the surface of the metal. Left: After cupping. Right: Surface and cup after peeling the film.

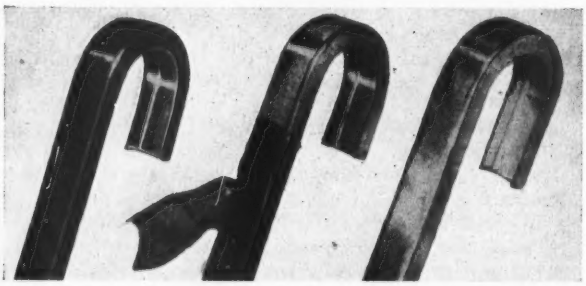


Fig. 6.—Protective qualities of plastic film are illustrated by this test specimen, which was formed into a channel and then bent 180° with the film intact. Left to right: After coating and forming, partially stripped, completely stripped.

Corporation included the "liquid envelope" material. Their object was to provide protection at the manufacturing stage, and for this protection to withstand handling, transport, storage, and, finally, fabrication.

The "liquid envelope" plastic gave promise from the initiation of this work. Applying the usual Erichsen cupping test to coated material, it was noted that the liquid envelope coating did not fracture during the formation of the cup. Fig 5 shows this, namely, the cup is the coated material, with the clamping mark around the cup, and the same sample after the stripping of the coating, with the metal surface unimpaired. Various types of severe deformation tests were then made, including flat bending, tension tests, and channel bending in a small Di-Acro bench brake. The channel specimen is the subject of Fig. 6. For this test the material was coated on one side only with a liquid envelope film thickness of approximately 0.0015 in.; the channel was formed, and then the double bend through 180 degrees was made. It will be noted that the film did not rupture or peel, and that the surface of the steel was unimpaired, as demonstrated by the specimen coated, partially stripped and completely stripped. It was in making these bends that it was observed less effort was expended on the coated specimens than on uncoated ones.

Practical trials were also made on stainless-steel sinks, one of which is shown in Fig. 7. In one case, No. 4 finish 16 gauge stainless-steel sheet was coated with liquid envelope on the top side, and formed in a single draw on a 1,600-ton Toledo mechanical toggle action press into sinks of dimensions 8 ins. deep, 16 ins. wide and 19 ins. long. The results were entirely satisfactory; the coating did not tear, it provided protection to the surface not only during drawing but also in prior and subsequent handling, and, moreover, it was still easily strippable after the operations were completed. It was also considered that the coating improved lubrication between work and tool.

The Portland Copper and Tank Works Inc., South Portland, first used "liquid envelope" coating on stainless-steel sheet for deep drawing sink bowls on a 350-ton press, and found it gave the following advantages:—

(a) Complete elimination of scratching.

(b) Hand polishing or finishing was unnecessary.

(c) Eliminated the galling and consequent hand-stoning of dies.

(d) Reduced the consumption of drawing compound.

(e) Coating did not peel or break during the drawing operation, and it remained an integral part of the pressing.

(f) Coating was easily removed by peeling at the shipping stage.

(g) Natural beauty of the original polished stainless-steel sheet was retained.

Uchtorff Co. Inc., Davenport, Iowa, have had similar experiences in pressing stainless-steel sink bowls. Without liquid envelope they find no undue difficulty in polishing the finished article, but scratches result wherever the metal moves during

Fig. 7.—Sink bowl, deep drawn from stainless-steel sheet coated with a plastic film. The coating was on the sheet when the bowl was drawn. (Photo: Courtesy, "Iron Age.")

drawing, and these scratches are most severe in the corners, where it is most difficult to remove them. With liquid envelope, however, they experience no scratches whatsoever, and find the cost of the coating and its application considerably less than that of grinding out and polishing of scratches.

This company produces the sink bowl in a 400-ton Lake Erie hydraulic press with pneumatic-hydraulic cushions of 175-ton capacity. The material employed is 18 gauge type 302 stainless steel with a No. 4 finish. The approach speed of the press is 110 ins. per min. and the pressing speed 13 ins. per min. The full available tonnage of the press on top and bottom is necessary to prevent the metal from wrinkling or tearing. The dimensions of the finished bowl are 7½ ins. deep, 14 ins. wide and 15½ ins. long, and it is drawn without any annealings. The material naturally work hardens in the fabrication processes, but no bowls ever crack owing to stresses. Three operations are involved. In the first, the flat blank is drawn to 7⅛ ins. in depth, using a draw-punch with a flat bottom and a $\frac{1}{16}$-in. taper on the sides. Thus the flanged top is produced to size, and the bottom $\frac{3}{8}$ in. undersize on length and breadth. In the second operation the full depth and

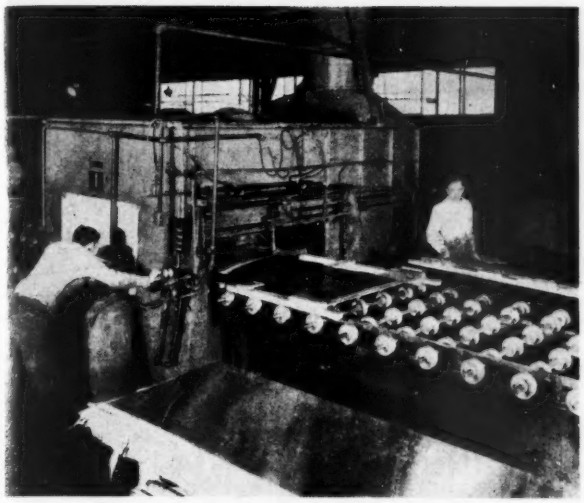


Fig. 8.—Automatic plant at Eastern Stainless Steel Corporation for applying "liquid envelope" to stainless-steel sheets: view of charging end. (Photo, courtesy "Iron Age.")

length and breadth are produced, and the drainage bulge in the bottom is formed. In this operation the bulges in the flanges and flat sides, caused by the upset, especially from the corners in drawing, are also corrected by stretching. A third operation is necessary to form the drain hole and the drain-hole flange.

Research continues upon the rather obscure but interesting problem of the behaviour of "liquid envelope" in the drawing operation and other cold-forming fabrication processes. The general facts so far established, however, are as follows:—

(1) "Liquid envelope" is an excellent medium for the protection of metal sheets in handling, shipping and storage, and during fabrication processes, whether these processes be mild or severe.

(2) The coating eases the flow of the metal, serving as a soft cushion, and improves the efficiency of lubricants.

(3) Stainless steel, in certain cases, can be deep drawn without intermediate annealing and cleaning operations.

(4) The coating enables finishes to be maintained on completed components which would be difficult or impossible to reproduce by other finishing methods.

The coating may be applied by dip, brush, roller, or extrusion, as well as by spray. When welding is necessary, the coating is stripped from the weld area, and when welding is completed the welded area is re-coated. For deep drawing, experience indicates that the best thickness of "liquid envelope" coating is from 0.0015 in. to 0.0025 in.

To meet the large demands of coated, polished stainless-steel sheet, Easter Stainless Steel Corporation have had to design and install automatic plant for applying the "liquid envelope." This plant (Fig. 8) provides continuous flow through an automatic degreaser, then through the automatic spray of "liquid envelope" and, finally, an infra-red drying unit. From this the sheet is then ready for shipment.

(To be continued.)

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Machinery Belting

Sir,—We shall be glad to know if there are any British manufacturers of extruded plastic belting, which has a core of thin string or fabric to obviate stretching when the belt becomes warm through constant use. Extruded plastic belts are ideal for use with certain types of machine, but the fault due to stretching is difficult to overcome. The sizes required are 6 mm. diameter by 3.5 metres long and 8 mm. diameter by 2.7 metres long.

D. AND D.

[EDITOR'S NOTE: We do not know of any concern making belts of p.v.c. extruded over fabric. The British Belting and Asbestos Co., Ltd., of Cleckheaton, near Leeds, we understand, employ the process of coating fabric with p.v.c.; presumably, that process overcomes faults due to stretching.]

Weaving P.V.C. Filament

Sir,—We enclose herewith a small piece of extruded p.v.c. filament. One of our customers is anxious to learn the name of any weavers who would be prepared to make this type of extrusion into a fabric.

A. B. BREWER AND CO. (PLASTICS), LTD.

Arle Farm, Cheltenham.

[EDITOR'S NOTE: We suggest that you get in touch with the following:—Fothergill and Harvey, Ltd., 37, Peter Street, Manchester; Clutsom and Kemp, Ltd., Highfields, Coalville, Leicestershire; Jones, Stroud and Co., Ltd., Vide Mills, Long Eaton, Nottingham; and Rotunda, Ltd., 5, Abbey House, London, S.W.1.]

Conducting Silver Paste

SIR,—We shall be glad if you will supply us with the name and address of firms manufacturing the conducting silver paste mentioned in the article by E. E. Halls in the December, 1949, issue of "Plastics" (page 132).

"WORKS CHEMIST."

[EDITOR'S NOTE: The widest range of silver pastes for conductive printing on thermo-setting and thermoplastic materials is supplied under the trade name of "Elargol" by Ward, Blenkinsop and Co., Ltd., 6, Henrietta Place, London, W.1.]

P.V.C. Sheath for Flexible Tube

Sir,—We shall be glad if you can advise us of any firms who are covering flexible metallic tubing with a p.v.c. sheath; alternatively, any firms who could undertake such work. The sizes of the tubing would range from $\frac{1}{16}$-in. bore up to about 2-in., and the quantities would be substantial.

W. R. CRAWLEY, LTD.

17, Elm Street,
Grays Inn Road, London, W.C.1.

Plastics for Home Crafts

SIR,—We are anxious to contact manufacturers of plastic materials suitable for home craftwork applications. Our magazine, "Craftworker," caters for the specialist worker directly interested in the production of high-quality craft goods, either for sale or personal use. We are willing to consider any suitable material, but make the stipulation that the substance must be available to the general public in small quantities.

"CRAFTWORKER."

The Broadway,
Broadstairs, Kent.

Cocktail Cherry Sticks

Sir,—I would be extremely grateful if you would tell me where I can obtain a supply of plastic cocktail cherry sticks.

W. R. DAVIES.

87, Hamlet Court Road,
Westcliff-on-Sea.

Polyvinyl Acetate

With regard to the letter from "Polyvinyl," published in the February issue of this journal, and which inquired for makers of polyvinyl acetate as "dry powder," we trust it is quite clear that the solid granular form is, and always has been, available in this country from Shawinigan Ltd., Marlow House, Lloyds Avenue, London, E.C.3. The solutions just on the market by certain concerns are in fact made from the solid. So far as we know there is not a "powder" or "flour" form.

New Productions in Plastics

Miniature Dolls

These sturdy little dolls, each 2 to 2½ ins. in height, are from a range of such playthings injection moulded in "Vybak" material by Poplar Plastics, of New Street, Trading Estate, Bridgend, Glamorgan. As will be seen from our photograph, these mouldings have a "fully dressed" appearance, and are sufficiently well balanced to enable them to stand unsupported, so that they suggest use as miniature characters in an appropriate toy theatre setting.

Cable Jointing Sleeve

The "Helvin" jointing sleeve, which is the subject of one of our illustrations, is made by Hellermann Electric, Ltd., Timsley Lane, Crawley, Sussex, for use on underground cables. Being fitted over the plumbed joint, it makes the cable insulation continuous. "Helvin" is a thermoplastic based on vinyl chloride and is a rubber-like material which is resistant to oils and most acids and alkalis. Parts can be economically produced by moulding, or by other processes, without high tooling costs.

Re-designed Viewer

The "Jafro" viewer for viewing colour transparencies was first designed in 1947 and went into production in 1948. Plastic was chosen for its lightness and strength, for "feel," colour appeal, and minimum production costs.

In its original form the viewer was acclaimed a first-class design, but experience showed that various small practical modifications could be made which would improve the handiness and performance of this instrument. Accordingly, the designer, R. E. Brookes, has now moved the screen further forward, so that it is completely out of focus under all circumstances. The material from which the screen is made is acetate sheet and in its original position the grain in this material showed up slightly—a small disadvantage which has been entirely overcome by the small modification mentioned.

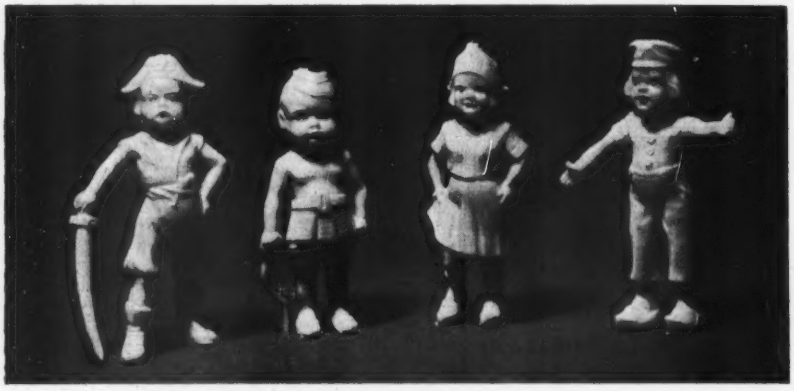
Another modification is the incorporation in the underside of the body, of a small slot which enables strips of 35 mm. film to be fed through a special adaptor which is now supplied with the viewer. Finally, the eye-piece has been rendered more easily adjustable by the incorporation of fine moulded ribs which were lacking on the original design.

An interesting point regarding production of the new design is that it has been possible to utilize the original tools for the body and eye-piece after these tools had been suitably modified.

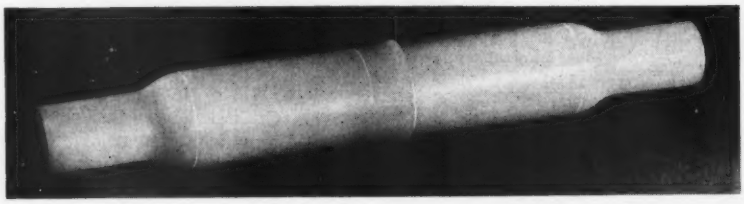
The body of this viewer is moulded in grey "Scarab" material; eye-piece and screen rim, in red "Beetle." The moulders are Brookes and Adams, Ltd., Hockley, Birmingham.

Orthopædic Surgery

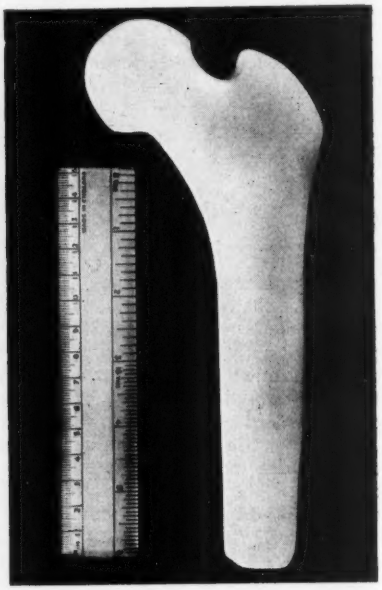
As the result of disease of the bone it was necessary recently at the Royal Orthopædic Hospital, Stanmore, Middlesex, to amputate a leg. However, if this operation had been carried out in the usual way an artificial leg would have been needed with which it would not have been possible for the patient to walk satisfactorily. Part of the femur was therefore prepared in "Alkathene," and inserted into the hip-joint in such a way that some muscles passed through slots cut in the femur. The amputation stump healed satisfactorily and the patient can now walk by means of a normal artificial leg.



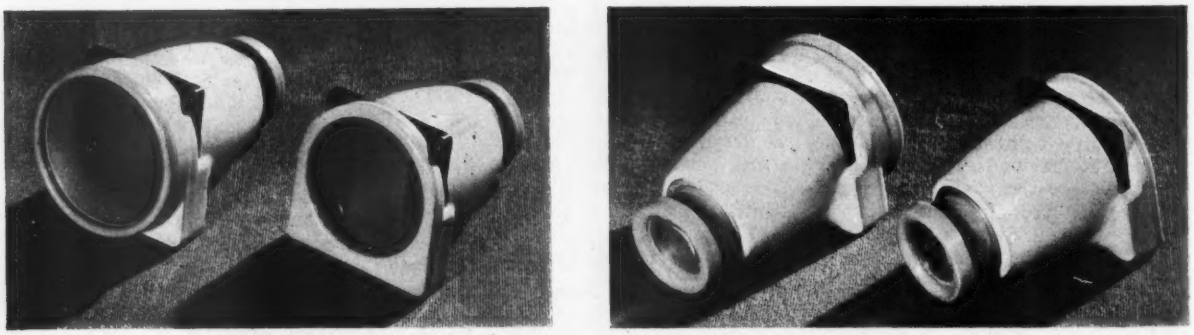
Miniature dolls injection moulded in "Vybak" material.



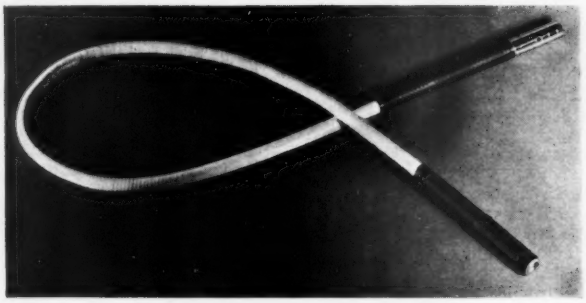
Jointing sleeve for underground cables.



Artificial femur, moulded in "Alkathene," for orthopædic surgery.

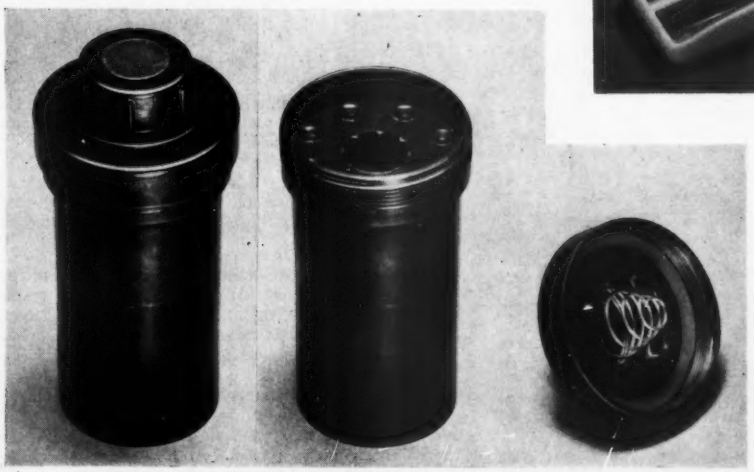


Redesigned viewer, compared with original design, left and right respectively in each photograph.



Flexible shaft for dental drilling machine.

Magnifiers of new design.



Moulded case for surgical syringes.

Road marking moulded in p.v.c.

Laying the "Flareline" prefabricated marking on the road surface.

Flexible Shaft

Flexible shafting is now being covered in p.v.c. by Creators, Ltd., Kings Road, Addlestone, Weybridge, Surrey. Our illustration shows a flexible shaft of this type as used on a dental drilling machine. Hitherto such shafting was sewn over with leather. In this particular example, two reinforced mouldings of hard p.v.c. have also been added at the extreme ends to protect the part of the shaft that enters the metal turning.

Surgical Syringe Case

Moulded from odourless phenolic material by Universal Metal Products, Ltd., Pendleton, Salford, Lancs, for Surgical Equipment Supplies, Ltd., London, this spirit-proof syringe case comprises three parts—body, insert and iid. The insert can be interchanged for 5, 10 and 20 c.c. syringes; the centre hole accommodates the syringe, and the holes around the rim of the insert are used to hold the needles. The lid is fitted with a metal spring to hold the syringe in position. The distributor's name is embossed at the base of this container, which is specially designed so that the syringe can be kept in surgical spirit.

Road Markings

The "Flareline" system of prefabricated units for permanent "white centre line" road marking are moulded in thin strips from a specially compounded white p.v.c. material. Reflectors in the form of small spherical beads of specially hardened Czechoslovakian glass are embedded firmly in the plastic base. The strips are fixed on the road surface by the simple application of a type of Bostik cement, and are anchored by two Parker-Kolon masonry spikes to ensure that they remain exactly in position. The strips are claimed to be resistant to oil, petrol, heat and frost; they also resist the tendency to spread under heavy load. Longer life than existing markings, and ease and speed of fixing—two men can lay the unit in a few minutes—are also properties which are valuable and pertinent to this purpose. The size and shape of the units are such that two of them can be laid end to end to form the regulation "spot" of 3 ft.

These "Flareline" markings are already in use by the West Sussex County Council, on part of the Selsey-Chichester road. They are produced by Industrial Chemicals, Ltd., Victoria House, Southampton Row, London, W.C.1, who also make similar units without reflectors (known as "Lifeline"), which are designed for use where street lighting makes reflectors unpracticable; these have been fixed on part of Southampton Row, London, W.C.1.

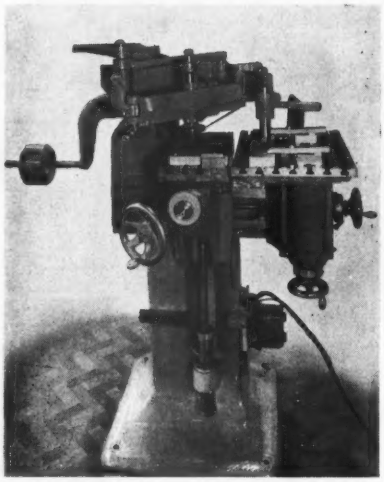
Our illustrations show one of the "Flareline" units and the process of laying them on the road surface.

Magnifiers

The designs adopted for these magnifiers, by Combined Optical Industries, Ltd., Plasta Works, Bath Road, Slough, Bucks, are pleasing and in particularly nice proportion. The cream components or holders are moulded in I.C.I. "Diakon" methyl methacrylate powder. The optical surfaces of the lenses are moulded from machined preforms of "Transpex I" acrylic sheet; "Transpex I" is also an I.C.I. product. The actual optical form of the lenses is such that small printed characters are more easily read than with a lens of the conventional design.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

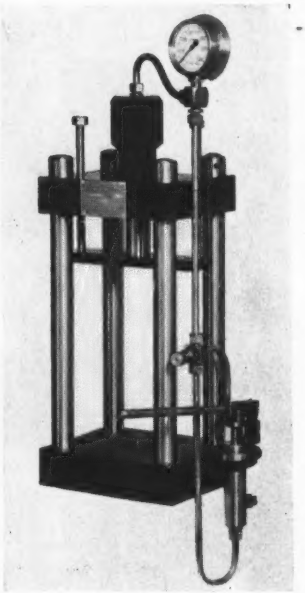


DIE-SINKING MACHINE.—The accompanying illustration shows the G16 die-sinking machine of Technical Machines and Accessories, Ltd., 16, Finsbury Square, London, E.C.2, which is three-dimensional and suitable for the accurate reproduction of regular or irregular profiles and contours in any plane. It is therefore a particularly useful machine for the production of all types of moulds for the plastics industry. The size of the worktable is 8 ins. by 13¾ ins.; cross movement 7 ins., longitudinal movement 8 ins., and vertical movement 7 ins. The size of the copytable is 13 ins. by 18 ins., giving vertical movement 5 ins. and longitudinal movement 7 ins. The pantograph has three-dimensional movement, but can be set to a two-dimensional position by means of a spacing attachment which is provided. Any ratio from 1.5 : 1 to 10 : 1 can be obtained by a simple setting.

DRYER AND PREHEATER. — The "Chandos" rotary dryer and preheater, by Chandos Engineering Co., Ltd., 17, High Street, Egham, Surrey, has been specially

designed to ensure a continuous feed of dry and preheated powder or granules direct to the hopper feed chamber of injection-moulding and extruding machines. Its use not only eliminates blemishes in mouldings, but also reduces the heating requirements of the heating chamber of the machines. The unit is heated by means of "Inconel" sheathed radiant elements, and the standard temperature of 200 degrees F. and speed of delivery of material can be varied to suit requirements. The standard hopper takes 45 lb. of powder per charge, which is dried in one hour at the standard delivery speed and temperature. The current consumption is as low as 750 watts.

MOULDING PRESSES.—The Electro Hydraulic Equipment Co., of Coleshill Road, Curdworth, Birmingham, have recently developed several new moulding presses for the plastics industry. Their 10-ton hand-



operated hydraulic press, here illustrated, is of the 4-column down stroking type, with a single-cylinder, toggle action plunger pump. Maximum daylight is 18 ins.; minimum daylight, 11 ins. The diameter of the ram is 2 ins.; stroke of ram, 7 ins. Working area of base is 10 ins. by 7½ ins. The press is fitted with standard accessories, pressure gauge, and 3-way pressure release valve Electrically heated platens can be supplied upon request.

STANDARDIZED TIPPED TOOLS.—A. C. Wickman, Ltd., Tile Hill, Coventry, have sent us a copy of their new "Wimet" Standard Tools Manual. They inform us that the leading manufacturers of tungsten carbide tipped tools have found, by extended research into customers' requirements, that a number of sizes and shapes of carbide tipped lathe tools, at present listed as standards, have become redundant. The present range of standard tools constitutes over 260 shapes of tips, which, by restandardization, has now been reduced to 116 without affecting the range of application. Many of the new tools have been designed with primary and secondary rakes for better cutting efficiency, and to enable tools to be employed on a variety of work with little modification to rakes. It is intended that the new tools shall be available from April 1, 1950, onwards. With the new manual is included a booklet which individually compares the new series tools with the old series which they supplant.

SUNVIC CONTROLS, LTD., 10, Essex Street, Strand, London, W.C.2, makers of the "Sunvic" hotwire vacuum switches, which provide a highly reliable relay link actuated by a very small control current and capable of switching in or out loads up to 10 kW per tube, inform us that hitherto the tubes have been supplied either loose or mounted with accessory equipment in Bakelite boxes. Numerous industrial applications, however, call for complete panel units suitable for mounting in switchgear compartments or in metal boxes, which may be of standard conduit type. This arrangement is now provided by the new Type PN relay, consisting of from one to three standard "Sunvic" hotwire vacuum switch tubes mounted with appropriate resistances and surge-suppressors on an insulated baseplate.

MACHINERY IMPORT LICENCES.—A revised form of application for import licences for machinery, plant appliances and parts, has been introduced by the Import Licensing Branch of the Board of Trade. Applications on the old form of application for machinery licence will continue to be accepted and the change-over will be gradual.

BRITISH INDUSTRIES FAIR.—Organizers of the 1950 B.I.F., to be held May 8 to 19, at Earls Court and Olympia, London, and at Castle Bromwich, Birmingham, have commenced distributing a record total of advance B.I.F. catalogues to more than 100 territories. The final editions of the London and Birmingham catalogues will be published on May 8, the opening day of the Fair, and will be distributed to overseas buyers as they arrive at Earls Court, Olympia, and Castle Bromwich.

U.S. NATIONAL PLASTICS EXPOSITION.—The Society of the Plastic Industry, Inc., has invited producers and users of plastics from other countries, including the United Kingdom to take part in the 4th National Plastics Exposition in the United States. The Exposition will be held at the Navy Pier, Chicago, Illinois, March 28-31. Individuals or organizations desiring to participate are asked to communicate with Mr. William T. Cruze, Executive President, Society of Plastic Industry, Inc., 295, Madison Avenue, New York, 17.

BAKELITE EXHIBITION.—An exhibition of "Bakelite," "Warerite" and "Vybak" plastics will be held in the Exhibition Rooms of the British Colour Council, 13 Portman Square, London, W.1, March 9 to 17 (Mondays to Fridays only, 10 a.m. to 6 p.m.). The central feature will be the Bakelite Travelling Exhibition, which has recently been shown in Brussels, Oslo and Stockholm. In addition, a number of larger items will be included which it was not possible to send overseas. The exhibition is designed to illustrate the very wide range of applications of plastics to industry, and should be of interest to manufacturers who are interested in improving their

products and cutting costs and production time. Admission to the exhibition will be by ticket only. Bakelite, Ltd., inform us that they will be sending out a large number of tickets, but if any reader has not received a ticket by the end of February and wishes to have one, he should write to Bakelite, Ltd., 18 Grosvenor Gardens, London, S.W.1.

EXPORTS TO U.S.A.—An American concern, British Overseas Mart, Inc., of 1775, Broadway, New York, has been formed to set up a complete sales organization with a new plan for selling British-made goods, including plastics, in the U.S.A. One of the principals in this venture is Mr. William Carduner, who will be visiting this country shortly to contact the plastics industry. He is also a principal of British Industries, Corp., of New York, which represents with outstanding success several well-known British engineering concerns in America.

CAREERS ADVISORY BUREAU.—The Federation of British Industries propose to set up a Public Schools Careers Advisory Bureau serving between 100 and 150 public and grammar schools. The object of this Bureau is to provide classified information about candidates for employment and to promote direct discussion between schools and business firms. Further information may be obtained from F.B.I. Education Section, 21, Tothill Street, London, S.W.1.

PLASTICS WELDING IN HOLLAND. The first training course for welders in thermoplastic materials has taken place in Holland, where a nucleus of 12 welders have been instructed at the Kunststoffeninstituut, Delft, in the welding of polythene and rigid polyvinyl chloride. The theoretical part of the course was handled by Mr. G. Haim, of Rediweld, Ltd., London; the practical side was in the hands of Mr. J. T. Smith, of the same firm. It is intended to hold similar training courses at regular intervals at Delft, in order to make fabrication of thermoplastic materials more popular in Holland.

CELLULOSE ACETATE.—It is announced that the Cellulose Acetate Moulding Powder Manufacturers' Association has been dissolved.

MONSANTO CHEMICALS, LTD., announce the formation of a new company, Monsanto Chemicals of India, Ltd. The new company, which will handle Monsanto activities in India, is jointly owned by Monsanto Chemicals, Ltd., and its American associates, Monsanto Chemical Co., St. Louis, Mo. The registered offices are in Bombay and the directors include W. M. Rand (president, Monsanto Chemical Co.), and Edw. A. O'Neal, Jnr. (chairman, Monsanto Chemicals, Ltd.).

SHELL CHEMICALS, LTD., announce that Mr. S. W. Farrington will be taking over their Scottish Division, with office at 28, St. Enoch Square, Glasgow, in succession to Mr. C. Duckworth, who becomes manager of their Midland Division, at King Edward House, New Street, Birmingham. Mr. Duckworth succeeds Mr. J. A. Porter, who is taking up a post at the company's head office in London.

ASHDOWNS, LTD., inform us that they are now in a position to meet the American specification for the production of glass cloth and glass cloth/cotton cloth laminates for ducting, wall lining and flooring of aircraft and other purposes. Supplies of these materials have already been made to certain aircraft manufacturers for the purposes specified.

SIGN AND METAL INDUSTRIES, LTD., have recently finished a contract for converting an old-fashioned counter at the Chelmsford Post Office into a modern counter, constructed mainly of I.C.I. plastics, and "Bakelite" and "Traffolyte."

UNITED EBONITE AND LORIVAL, LTD., announce that all the future production of "Ply-Vic" table covers will be "non-inflammable," thus relieving anxiety of users with regard to fire risk and local safety regulations. These "Ply-Vic" table covers are made by M. H. Craston, Ltd., using Lorival material.

REED BROTHERS (ENGINEERING), LTD., announce the appointment of Mr. T. F. McHardy as manager of their chemical plant section in place of Mr. P. Richfield.

LEATHER RESEARCH.—The British Leather Manufacturers' Research Association announce that all future communications should be addressed to the Director of Research, at Milton Park, Egham, Surrey.

DR. W. H. GARRETT, director of Monsanto Chemicals, Ltd., has been presented with the University of Liverpool Chemical Society's Medal for 1950. This medal is awarded annually to a graduate of the University who has rendered distinguished service to chemistry in the academic or in the industrial sphere.

NOTES FROM THE BRITISH PLASTICS FEDERATION

New Members

PLASTICS MATERIAL MANUFACTURERS' GROUP (Sheet Section):—Commercial Plastics, Ltd.

FABRICATORS' GROUP (Extruders Section):—Associated Technical Manufacturers, Ltd.; Ega Electric, Ltd.; Rist's Wires and Cables, Ltd.

Annual General Meeting and Luncheon

The Council has resolved that the Annual General Meeting of the Federation should be held on March 15, 1950, at 2.30 p.m., in the Federation offices.

The Federation Annual Luncheon is to be held at the Savoy Hotel, London, on Wednesday, April 19, 1950.

Industrial Broadcasts

The Federation of British Industries have stressed the desirability of publicizing British industry by B.B.C. industrial broadcasts. This matter has been referred by the Council to the Publicity Committee.

Royal Society of Arts Lectures

The Federation has been invited by the Royal Society of Arts to arrange for a series of three lectures under the Cantor Bequest. It is expected that these lectures will be given early in 1951.

Engineers' Group

For the first time since its formation in 1944, the Engineers' Group held a meeting in Birmingham on January 10, 1950. This meeting was preceded by a meeting of the Plant Makers' Section and a Section luncheon. It is hoped to hold further meetings of the Engineers' Group in Birmingham from time to time.

Main Technical Committee

A meeting has been held between representatives of the Main Technical Committee and the Council of Industrial Design to discuss the Festival of Britain. The plastics industry will be directly concerned with the industrial section and the Dome of Discovery of the South Bank Exhibition and the more strictly scientific exhibit which will probably be held in the Science Museum, South Kensington. The Main Technical Committee is advising the Council of Industrial Design on these matters.

Sea Freights

Negotiations are continuing with various shipping Conferences for the classification of shipping freights. Agreement has already been reached with the Indian Conference Lines and negotiations have been opened with various European shipping lines.

Phenol and Cresol

A joint meeting has been held between the consumers of phenol and cresol and the Tar Acids Section of the Raw Material Suppliers Group. The supply position and the requirements of consumers were discussed in some detail.

FORTHCOMING MEETINGS

Mar. 10.—"Recent Developments in the Surface Coating Industry." F. Armitage. Society of Chemical Industry, London and East Anglia Section. Public Library, Ipswich. 6.30 p.m.

Mar. 10.—Film Evening. Plastics Institute, North-Western Section. Engineers' Club, Albert Square, Manchester, 2.

Mar. 14.—"Degradation and Weathering of Plastics and Rubbers." A. R. Burgess (I.C.I., Plastics Division); G. L. Hammond (Ministry of Supply). Society of Chemical Industry, Plastics Group. Royal Society of Tropical Medicine, 26, Portland Place, London, W.1. 6.30 p.m.

Mar. 15—"Adhesives," F. Chapman (Aero Research, Ltd.). Plastics Institute, Southern Section. Polygon Hotel, Southampton. 7.30 p.m.

Mar. 17.—"Plasticizers for P.V.C." H. Jones (Geigy Co., Ltd.). Plastics Institute, Midland Section. James Watt Memorial Hall Institute, Gt. Charles Street, Birmingham. 6.30 p.m.

Mar. 23.—"Protein Plastics." J. H. Collins (Erinoid, Ltd.). Plastics Institute, London Section. Waldorf Hotel, Aldwych, W.C.2. 6.30 p.m.

Mar. 24.—Plastics Institute, Midlands Section. Dance. Botanical Gardens, Birmingham.

Mar. 25.—Plastics Institute, London Section. Dance, Victoria Hall, Bloomsbury Square, W.C.1.

Mar. 28.—"Thermoplastics and their Application." A. D. Clarke (Commercial Plastics, Ltd.). Plastics Institute, North-Eastern Section. Neville Hall, Newcastle on Tyne. 6.30 p.m.

Apr. 5.—"Review of the Past 10 Years of the Industry and of the Economic Problems." Dr. W. E. de B. Diamond. Plastics Institute, Yorkshire Section. St. Mark's House, 186, Woodhouse Lane, Leeds. 7 p.m.

Apr. 11.—"Technique of Osmometry of High Polymers." Dr. D. Cleverdon and Mrs. D. Laker (Distillers Co., Ltd.). Society of Chemical Industry, Plastics Group. Royal Society of Tropical Medicine, 26, Portland Place, London, W.1.

"PLASTICS" INDEX.—The Index for "Plastics," Vol. 14, August to December, 1949, has now been published. Copies may be obtained from Temple Press Ltd., Bowling Green Lane, London, E.C.1, price 1s. 1d. post free.

Successful Designing for Plastics Moulding—VIII

By W. M. HALLIDAY

AS will be more fully explained in succeeding articles, the requirements of mould design and construction may often exert a profound influence upon the design forms which can be adopted in the component. This applies equally with both compression and injection type moulds.

The following general component-mould design features should be constantly in view throughout the stages when the exact character and form of the finished component is being finalized in readiness for commencing mould designing.

(A) Simplicity of Cavity Formation

In the first place, it has to be remembered that a cavity shape of the reverse form to that required on the finished moulding will have to be machined, cut or otherwise produced within the steel mould. This latter must comprise at least two main members or blocks, matched up on one face, known as the parting line, in order to permit full access whilst machining in the requisite cavity formations. These latter may be contained entirely within a single mould block, or partially within each member according to the particular shape of the component.

For this purpose the shape of the moulded article must be of such a character to permit this machining, etc., often of a most complicated and precision nature, to be performed accurately, as simply as possible and economically.

In cases where portions of the cavity area have to be formed in each mould block, questions of accurate matching will arise for the toolmaker, and here again the shape of the component adapted in accordance with due consideration of this point may often conduce to simplified construction.

Unless precision matching of cavity portions is accomplished, there may be the risk of producing components misshapen at certain points on their surface, or dimensionally inaccurate. Such risks will be particularly apt to occur in the case of parts of intricate configuration.

(B) Location of Parting Line in the Mould

The necessity to split the mould construction in the above manner to facilitate construction also means that parting-lines and the plane or planes at which they will be located on the component, will have to be judiciously considered and thoroughly understood whilst settling the final shape of the component.

This will become necessary for the following reasons :—

(a) To produce the least amount of flash formation upon the surface of the moulding. With both forms of moulding manufacture, owing to the pressures employed, the position of the parting line in a mould will always be reproduced as a slight marking or flash on the sides of the component. As a mould wears from continued use this flash line will tend to increase, perhaps to the stage of unsightliness.

(b) The parting line in the mould must be chosen in such a manner as to ensure the location of any resultant flash on the moulding in the most accessible place for subsequent removal by trimming tools, etc., or alternatively to ensure that it will be situated upon a surface not essential for the appearance of the part.

(c) The parting line in a mould design must also be selected with a view to the simple ejection of the finished moulded article.

(d) The parting line must also be situated in such planes or locations on the mould to permit it being readily opened after each set of articles has been produced.

(e) Mould parting lines must also be of the simplest shape in order to ensure a close seal being made over the whole area. For this latter object straight partings, in a single plane, are the best from the toolmaker's point of view. Irregular partings often incur considerable trouble during endeavours to match up the respective mould blocks in a sufficiently exact manner to obtain a close sealing contact over the affected area. This requirement will be particularly important in the case of injection moulds, where no leakage can be permitted across the parting line surfaces.

(C) Coring Provisions for Holes

Most compression and injection moulded components have usually to be produced with a number of holes, slots, openings or hollow internal formations of one kind or another.

These are nearly always reproduced in the mould by means of steel core plugs mounted in one or both of the mould blocks. Such cores may be affixed permanently within the mould, or carried in a reciprocating slide, or housed within a rotatable cylindrical rod carried in suitable bearings in the mould. In the case of such movable core plugs, special actuating mechanisms designed for manual, or mechanical operation may have to be introduced into the mould construction.

By moulding-in such holes, etc., a number of extremely important advantages can usually be obtained. These advantages may be very closely associated with the finish obtained on the surfaces of the component, its strength features and its accuracy. Certain advantages will also be derived by the mould designer, and during the actual production of mouldings when the tool is put into production service.

Considering the component first, intelligently planned coring will not only prove valuable by eliminating the need for subsequent drilling or milling on the component, but will also permit the amount of material to be maintained at the minimum level. Thus the cost per piece may be substantially affected and considerable economies gained. Material weight embodied in the component must, however, be related to the strength characteristics required in the part to withstand service conditions.

The quality of surface finish on the component may also very often be much improved by wise coring and the selection of suitable internal shapes lending themselves to economical reproduction. This advantage will accrue by reason of the reduction or even the elimination of undesirable shrinkage stressing and effects which would occur if large masses of material were concentrated at certain points on the article.

Heavy sections in a component to be produced as a compression moulding, for instance, might have a tendency towards under-curing and weakness in the completed article. Similarly with injection mouldings, thick sections may possess considerable porosity in the internal structure, coupled with surface sinks, and perhaps cracking tendencies associated with the thinner sections abruptly joined to the heavier portions.

The mould designer, too, will also derive considerable assistance from the use of cores in a mould. For example, it is often necessary to construct the mould in such a way that the finished component will always adhere to either the movable or the stationary mould block ; usually it is the former member. This is necessary to permit the component to be ejected quickly and effectively and safely from the mould. If core plugs can be used and arranged in the proper manner for this purpose, very reliable working of the mould will be ensured and the whole ejection procedure simplified to a great extent.

The designer also very often relies upon core plugs projecting into the cavity area to promote a better flow of the plastics material therein. This is especially the case with compression moulds. The size and location of the cores in relation to

the remainder of the cavity configuration is, indeed, often of paramount importance in this regard, and in designing practice it is one of the chief factors to be considered when developing the mould design, and deciding exactly how a component may be cored.

The use of cores may often provide one of the most simple and economical means for ensuring the uniformity of wall thickness throughout a component, which again is another very essential requirement with both compression and injection moulding, for the reasons to be explained shortly.

The mould user will also gain much assistance from a well-cored mould. Better mouldings may be produced with a minimum of trouble. Improved control over curing will be ensured. The length of cure can often be reduced by reason of the thinner wall sections employed. Sticking to cavity walls may be avoided if the component has a substantial core plug on which it may contract before the mould is opened.

The importance of correct coring will thus be appreciated from the above points, and it will be seen how essential it is for the component designer to give the most careful thought to this aspect of a design form to be selected.

Wherever practicable the designer should select those hole locations which permit core plugs being mounted in the mould at *right angles* to the parting-line surfaces. Holes, etc., situated at awkward or difficult inclinations to the parting of the mould may entail very great difficulties for the mould designer and user.

Holes should be continued clean through the component if possible to avoid having to use core plugs unsupported at the end projecting within the cavity area. In the case of a compression moulding having to be produced with a number of blind holes of small diameter but considerable depth, troubles may be experienced in the following manner.

The walls of the mould cavity and, of course, any projecting portions situated therein will be subjected to considerable thrust from the flowing plastics material in the mould. Unsupported and slender core plugs may thus easily be distorted, deflected or fractured as a result of being subjected to such pressure.

In addition, with most thermo-setting materials, a considerable abrasive action arises between the mould surfaces and the material during this flow stage. To make allowance for this abrasive action and resultant wear the mould designer will desire to make the core plugs to the *largest possible size* permitted by the tolerances allowed on the holes.

The core plug in course of time will wear smaller, and will have to be discarded when its diameter has worn down to the bottom dimensional limit allowed on the hole size.

To permit a reasonable length of working life to a core plug, it should preferably be amply supported at each side of the cavity formation. This means that holes should be formed clean through the wall of the component if practicable. It also means that the tolerance of the range of variation in size should be as large as possible.

Holes and openings, etc., should not have undercut portions which necessitate a larger size on the core at any point below the parting line of the mould. In other words, their shape should be of such a character as will ensure the largest diameter of the core being located on the parting plane of the mould blocks. If this is not accomplished it may be found that innumerable complications arise in connection with the mould construction and operation. Thus, in the case of a compression mould, it may necessitate the use of side splits, and loose bars in order to core in the required undercut portions. Introduction of such units will nearly always add to the handling time of the mould, and in many instances may also result in the formation of additional flash lines on the exterior of the component by reason of the extra intersection or jointing lines contained in the mould.

If undercut portions have to be formed in the walls of an injection moulding it may require using collapsible core plugs or other similar devices to allow the component to be readily removed when the mould is opened. This point will be more fully dealt with at a later point in connection with certain mould designs and constructions which it is intended to describe and illustrate.

Where a component has to be provided with several holes or openings through side walls, these should preferably be situated at right angles to each other rather than at unusual angles. This cannot always be done, of course, but where it can, usually considerable simplification of the mould construction will result.

Holes which pass clean through the wall of a component, which are termed " straight-through " holes, may be formed by a single core plug extending from one block into a guiding hole in the opposite block, or alternatively by means of a pair of plugs carried one in each mould block, and, of course, contacting very closely on their end faces when the mould is closed. This latter construction is often employed when the hole diameter is small and its length considerable. By using such a construction the two portions of the core will have very much greater stiffness and rigidity to resist deflection tendencies during flow.

Dual core plugs of this type must, of course, be very accurately located and fitted into the mould blocks so that proper alignment of the two portions is obtained when the mould is closed.

Threaded holes may also be cored. These are usually formed, with compression moulds, by means of sliding core plugs housed within a plain bearing hole in the mould block, and threaded on that portion extending into the cavity area. The core plug may have to be clipped into position in its housing by a spring or other device. The core will be extracted along with the finished moulding and removed later.

External threads may also be formed, either by the use of collars or sleeves introduced into the mould block in a somewhat similar manner as above.

Countersunk or counter-bored shape of holes may also be moulded in the wall of of a component. Holes which have to be subsequently tapped out are usually countersunk in this fashion to allow better lead of entry for the tap, and to prevent the raising of a burr on the edge of the hole.

The best locations of core plugs in a mould will be those where the axis of the plug is nearest in agreement with the direction of the maximum material flow and greatest pressure. If holes have to be cored at obtuse angles to this pressure direction it might be found advisable to omit them altogether from the mould and machine at a later operation. This point requires very careful consideration, especially if the component has a number of holes impinging at various angles into the cavity. The selection and disposition of such holes may best be determined by consultation with the mould designer. Alternatively, the mould designer should be allowed the widest latitude when developing the mould design.

(D) Ejection of the Component

It is also very necessary for the component designer to consider in some measure the particular manner in which the proposed component will have to be ejected out of the mould, and in particular whether the intended shape and form will lend itself to simple and quick ejection.

In the case of an injection moulded part, usually if the internal shape can be formed by means of a solid core plug, so much the better, because this will enable a simple push-off mechanism to be employed for ejecting it out of the mould. A number of cylindrical rods are generally used for this purpose, these being passed through holes in the movable block member, and affixed at the rear to a plate or other appliance capable of retaining them together. The whole ejector plate will be slidable within the mould block. The ends of the rods will be set level with the parting line surface of the block on the edge of the cavity. All the rods will have to be disposed relative to the cavity area so as to bear upon selected portions of the component wall.

The point which the component designer has to bear in mind in this connection is

this : Where each ejector rod touches the wall of the component a collar flash ring of some degree will be formed. Although such ejector rods are closely fitted within the block, a marking of some kind is unavoidable.

To obviate unsightly marking of essential surfaces on the moulded component, therefore, close attention must be given to the location of ejectors in relationship to those surfaces where the slightest blemish would prove undesirable. Sometimes ejection may be accomplished by means of a sliding sleeve, large enough in external diameter to cover the component at its widest diameter. The moulded article would thus be pushed off a core plug without producing any rod markings at all.

An alternative method often used is to make the core plug retractable within the mould block, so that the moulding will fall of its own weight when the core is drawn back at the appropriate instant after the mould has been opened.

These are all points well meriting the careful attentions of the component designer when he is settling the final shape and form of the part. If consultations can be made with the mould designer so much the better. He will often be able to advise quite simple modifications of shape, etc., for simplifying the essential operation of ejection.

(E) Requirements of Mould Construction

The shape of the component and the type of mould to be constructed are also very intimately related, which is yet another factor to be kept in view by the designer of a component. Whatever shape is finally selected, this will have to be produced in reverse form in a steel mould.

With some shapes it may be possible for the toolmaker to machine them directly into the mould blocks. Other forms may require a mould having a built-up type of construction, employing a number of separate mould units so arranged and fitted together to give the required cavity shape. Each unit may contain a portion of the cavity formation.

Two important considerations arise in this connection, which will claim the interest of the component designer.

The first is that of mould cost. A complex built-up construction required to reproduce a difficult shape may prove far more costly than a solid type of mould construction. Often a very small or simple alteration in the shape of a component will permit the latter kind of mould being employed rather than the built-up mould. Expert advice on this point should always be obtained from the mould designer.

The second point relates to the quality of the component. With a built-up type of mould construction it is very likely that there will have to be a number of intersecting jointing surfaces in addition to the normal parting line of the mould. These may be source of surface blemishes on the finished part by reason of the small flash arising therefrom. Such flashings and marks may prove difficult to remove, a task likely to add to the unit cost of the components. Here again this is a matter best decided by the mould designer, who should be afforded freedom to adapt the shape best to suit all requirements of mould construction and manufacture.

Very often where a built-up type of mould has to be employed it will be possible, by only slightly altering the shape to obviate numerous intersections and joints of the above kind. Alternatively beadings, ribs, or steps, may be added to the component shape locating such features at the points where mould joints occur. Markings, etc., will then tend to be much more concealed and less conspicuous.

The mould designer's efforts to this end will often be greatly promoted if the component designer in the first instance has duly considered the point and endeavoured to develop a shape in conformity with these and other requirements of mould construction.

(F) Determination of Flash Lines

To a considerable extent flash formation depends upon the general quality, accuracy and design of the moulding tool. This is particularly so in respect of injection moulded articles.

Given a properly inter-related component shape to mould design and construction in conformity with the various factors already discussed in this article, flash should be maintained within negligible proportions, and should not become a serious problem at all.

With practically all forms of compression moulding, however, the determination of the flash line location upon the component assumes very much greater importance.

With this process of manufacture, when employing moulds other than those of the positive type of construction, it is customary to load the mould with a quantity of plastics material in granule, powder or pellet form, slightly greater than the calculated amount. The reason why this is performed is to ensure that complete filling out of the cavity area, and that *all the material* will be exposed to the moulding pressure imparted to the mould.

As the mould is closed any excess plastics material will be squeezed out between the lands of the mould blocks or through the spew channel provided to form a flash line around the component. This flash has to be removed by one means or another at a subsequent operation. It is essential that it be located at the most suitable points on the component to ensure quick and inexpensive removal and to avoid damaging the surfaces of the part as far as possible. Generally flash removal operations are fairly costly, usually they are performed by manual means, such as filing, trimming or hand polishing. The component may be held in a revolving collet or chuck and a file or linishing cloth applied to the affected part.

If the flash line on a compression-moulded article is located at an unsuitable point not only may difficulties be caused in respect of its removal, but the surface of the part may be marred.

These unsatisfactory features can often be greatly minimized or entirely removed if the component designer strives to fashion the shape and form of the article to conform with recognized principles. These are as follows :—

(a) The flash line should not be disposed in more than a single plane. Difficulties in removing the flash will be occasioned if this is not achieved.

(b) The flash line should be straight whenever it is practicable to arrange. Irregular flash lines are difficult to deal with, trimming tools, etc., cannot be applied easily to such surfaces, and there will always be the risk of some flash remaining to cause unsightliness.

(c) Preferably the flash line should not lie along a flat surface. The reason for this being that it is very difficult to remove the flash material without inflicting damage by scratching or rubbing the remainder of the surface of the part.

(d) Where it is unavoidable to locate the flash line other than on a flat surface it will often be found advantageous to add a lip or beading, along which the line would lie. This would make for simpler removal of the flash.

(e) Inscription panels, fluting for decorative purposes, or recessed portions on the side surface of a component should not be extended up to the flash line, for the same reasons given above.

(f) Endeavour to blend in the flash line with the general styling employed on the surfaces of the component as far as possible. Thus, in the case of an article having a number of ribs running along its whole length, it will be far better to locate the flash line along the crests of these ribs rather than across them.

(h) Try always to locate flash lines along a non-essential surface.

(G) The Wall Thickness of the Component

One other important point will also have to be settled by the designer of the plastics article, possibly in co-operation with the mould designer and engineer ; this is the matter of wall thickness to be embodied in the part.

From the cost viewpoint the thinner the walls moulded the less material will be used, and the cost of the component will be accordingly reduced. There will usually be a limiting factor in the shape of the strength requirements to be fulfilled by the finished article. The walls must

be left thick enough to stand up satisfactorily to the working conditions.

If the component is required as an electrical insulating medium as well, its wall thickness will have to be carefully determined in order to ensure maximum insulating capacities. Unduly thin walls, whilst being strong enough in a mechanical sense for the purposes in view, might be too thin to give best insulating results if the part acts as an insulator.

Wall thickness will be determined by the size of the component and the duties to be fulfilled. Very thin wall sections can be successfully moulded, viz., as low as .045 in. for the thermoplastics, and about .070 in. with thermo-setting materials.

If the component is only small in size and has very light mechanical functions to perform, the above figures would be satisfactory. On the other hand, if the component is very large, and to be compression moulded in thermo-setting substances, then it might be necessary to increase wall thickness up to as much as .350 in., or even slightly above this figure.

Thick sections of compression-moulded articles will require longer heating, and therefore the production cycle will be increased slightly.

The chief points to be observed in wall thickness design is that the thickness should be as *even* and *regular* as possible throughout the whole component. Sudden and large changes in sectional thickness should be avoided. Non-uniform wall sections may lead to numerous troubles in mould operation, and in respect of the finished quality of the article. Unequalized cooling stresses arising from uneven wall section may cause porosity, distortion or cracking of the thinner portions.

With compression-moulded components heavy sections might be under-cured, thus leading to weakness of the component at such points. Surface sinks and disfigurations may also occur in connection with the moulding of components of this kind.

In cases where the component is to be deeply cored the walls should be amply tapered, with the *thinnest portions nearest the parting line surface* of the mould.

A better flow will thus be obtained, and the material will flow upwards, away from the lower portions of the mould cavity. If the latter is fairly deep it may well be that by the time the material reaches the upper portions of the cavity it will have progressed well into the "cure" stage.

It will thus be appreciated that if the component design is such as requires the thicker portions of the wall to be located at the top of the cavity there might be a risk of under-curing or premature curing taking place, with resultant weakness in the finished component. Such a condition might also produce an improper "fill" and a partially-formed moulding.

It should be borne in mind that the strength of a wall may often be materially increased by the addition of a fillet, rib, beading or ledge at a particular point. By the use of such stiffening features the general wall thickness may often be maintained within small limits.

In the final determination of the wall thickness to be used it is nearly always advisable for the user or component designer to discuss the matter with the mould engineer, who will be able to advise more expertly in the light of the service requirements involved and the material being used, and the strength characteristics to be obtained.

(To be continued)

Testing Thermosetting Moulding Materials for Shrinkage

A SECOND edition of the German Standard DIN 53464, dated September, 1949, has been issued. Its purpose is to control the production of thermosetting hot moulding materials and to guarantee the uniformity of consecutive supplies of the same material. Further, it determines the suitability of a moulding material for the production of accurate moulded components.

Shrinkage of moulded components is defined as the difference between a dimension of the cold mould and the same dimension on the cooled-down moulded component on the day of moulding, the dimensions being referred to a temperature of 20 degrees C. Shrinkage is expressed as a percentage of the dimension of the cold mould.

Subsequent shrinkage is the difference between a dimension of the moulded component measured the day after moulding and again after heat treatment (200 hours) at a specified temperature—200 degrees C. for phenolic resins with an inorganic filler, 130 degrees C. for phenolic resins with wood flour and textile fillers, 80 degrees C. for urea resins, and for other resins a temperature to be agreed upon. The subsequent shrinkage is expressed as a percentage of the dimensions of the moulded part measured the day after moulding.

The main tests should be made on samples of 120 ± 1 mm. length, 15 ± 0.3 mm. width, and 4 ± 0.2 mm. thickness. The moulding powder used should correspond to an average sample. Moulding powders have to be preheated for one hour in a layer height of 10 mm. at a temperature of 60 to 65 degrees C. Moulding temperature, moulding time and moulding pressure are set out in the accompanying Table.

Within 30 seconds after the commencement of the opening of the mould, the sample is taken out and allowed to cool in air on a low heat conducting support. For plastics not mentioned in the Table special conditions have to be agreed upon. A minimum of five samples are tested, and these have to be moulded independently.

For the moulds for thermosetting test pieces, a draft Standard DIN 53470 (September, 1949) has also been issued. Three different samples are specified:—

(1) A moulded standard plate, 120 by 120 mm. side lengths, 3 to 4 mm. thickness.

(2) A moulded plate with six ribs, total measurements 120 by 120 mm., total thickness 4 mm.; the ribs have a width of 15 mm., the grooves a depth of 2.5 mm. and a width of 6 mm., and from this Standard flat bars, 4 mm. thick, are taken.

(3) A moulded plate, similar to (2) but 10 mm. thick, with a groove depth of 8.5 mm.

These three plates are moulded in the same mould, which has a rectangular cavity 120 by 120 mm., into which fits an upper and a lower moveable press ram, the different shapes being provided by an insert on top of the lower press ram.

Copies of these German Standards DIN 53464 and DIN 53470 may be obtained through the British Standards Institution, 28, Victoria Street, London, S.W.1.

Temperature, Time and Pressure in Moulding.

Moulding material	Filling time[1] sec.	Moulding temperature deg. C.	Moulding time[2] min.	Moulding pressure kg/sq.cm.
Phenolic resins with wood flour and textile fillers, the latter with short fibres	10±1	160 to 165	3	250 to 400
Phenolic resins with inorganic fillers and textile fillers, the latter being laminated	20±2	160 to 165	3	400 to 600
Phenolic resins with wood flour filler	10±1	160 to 165	5	250 to 400
Urea-formaldehyde with organic filler	10±1	140 to 145	4	250 to 400

[1] Calculated from the start of the filling-in until the increase in pressure.

[2] Calculated from the commencement of closing until the commencement of opening the mould.

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 2/- each.

B.P. 631,341. Appl. 14.2.47. Conv. (U.S.A.) 15.2.46. Acc. 1.11.49.

Copolymers of styrene. B. H. Kress. To: Standard Telephones and Cables, Ltd.

Refers to cross-linked polystyrene prepared by reacting cinnamic acid or 2-furfyl acrylic acid and a saturated polyhydric aliphatic alcohol with at least three hydroxyl groups, thus forming a monomeric ester, dissolving the latter in monomeric styrene copolymerizing afterwards.

B.P. 631,372. Appl. 24.7.47. Acc. 1.11.49.

Protective coatings of polyvinyl resin. C. E. Scoffom. To: Bakelite, Ltd.

Sprayable p.v.c. mixture consisting of polyvinyl butyral, tricresyl phosphate, methylated spirit and petroleum ether suitable for covering webbing.

B.P. 631,448. Appl. 2.7.45. Acc. 3.11.49.

Finishing treatment of fabric and garments of thermoplastic yarn. E. B. Bates.

Thermal treatment of nylon garments or stockings to impart dimensional stability.

B.P. 631,456. Appl. 14.6.46. Acc. 3.11.49.

Treatment of nylon and other thermoplastic yarns and fabrics knitted therefrom. P. Alexander, H. Burrows and P. D. Smith. To: Wolsey, Ltd.

B.P. 631,477. Appl. 7.3.47. Conv. (U.S.A.) 9.3.46. Acc. 3.11.49.

Improvements in moulding compositions. To: The Dow Chemical Co.

Refers to a polystyrene soybean oil composition.

B.P. 631,479. Appl. 26.3.47. Conv. (U.S.A.) 29.3.46. Acc. 3.11.49.

Synthetic resinous coating composition. To: Monsanto Chemical Co.

Protective coating composition comprising an alkyd resin and an alkoxy methylolmelamine condensation product which will remain clear and homogeneous upon drying.

B.P. 631,504. Appl. 5.9.47. Conv. (U.S.A.) 5.9.46. Acc. 3.11.49.

Dispersons of fluorine-containing polymers. To: E. I. du Pont de Nemours and Co.

Refers to aqueous colloidal dispersions of polytetrafluoroethylene.

B.P. 631,570. Appl. 1.12.47. Conv. (U.S.A.) 30.11.46. Acc. 4.11.49.

Suspensions of tetrafluoroethylene polymers. To: E. I. du Pont de Nemours and Co.

B.P. 631,590. Appl. 24.5.46. Acc. 7.11.49.

Improved synthetic resins. D. D. Coffman and H. W. Jacobson. To: E. I. du Pont de Nemours and Co.

Heat hardenable interpolymer resins produced by hydrolysing ethylene (vinyl acetate) fumaric ester interpolymers.

B.P. 631,598. Appl. 15.11.46. Conv. (Germany) 15.4.44. Acc. 7.11.49.

Injection moulding presses. V. Vltavsky.

B.P. 631,619. Appl. 1.7.47. Acc. 7.11.49.

A process for the manufacture of organosilicon compounds. J. T. Goodwin, Jr. To: Dow Chemical Corp.

B.P. 631,738. Appl. 2.10.46. Conv. (U.S.A.) 16.10.45. Acc. 9.11.49.

Preparation of ampholeric amides of acrylic acid and their polymers. G. D. Jones. To: General Aniline and Film Corp.

B.P. 631,844. Appl. 7.8.47. Conv. (U.S.A.) 7.8.46. Acc. 10.11.49.

Polymerizable materials and the polymerization thereof. To: E. I. du Pont de Nemours and Co.

Monomeric composition comprising a dimethacrylate ester of a glycol alone or in admixture with other polymerizable compounds, a monomer, soluble inorganic cobalt salt and another catalyst if so desired.

B.P. 631,917. Appl. 7.10.47. Acc. 11.11.49.

Moulding compositions containing acrylic polymers and the application thereof. S. A. Leader.

Moulding composition comprising an acrylic polymer and up to 0.25 per cent. of a silicone.

B.P. 632,024. Appl. 14.1.48. Conv. (U.S.A.) 10.12.42. Acc. 15.11.49.

Preparing aqueous dispersions of an acid-reacting synthetic resin. To: Monsanto Chemical Co.

Aqueous dispersion is made of an ethylene α,β-dicarboxylic acid and a terpene. Used in the sizing of paper to obtain improved products.

B.P. 632,040. Appl. 1.1.48 and 27.2.48. Acc. 15.11.49.

Means for heating resin kettles and other vessels used for containing other gums, oils and like materials. J. J. Stordy. To: Stordy Eng. Co., Ltd.

B.P. 632,050. Appl. 21.1.48. Acc. 15.11.49.

Manufacture of a paper-like material from calcium alginate artificial silk. J. R. Cairus, S. R. H. Edge. To: Wiggins, Teape and Co. (1919), Ltd.

Manufacture of a paper-like material from calcium alginate, which is non-inflammable and can be easily dissolved in alkalies, which makes it particularly suitable as a foundation for embroidery, etc.

B.P. 632,083. Appl. 10.2.47. Acc. 16.11.49.

Coloration of polyamide fibres. A. Butterworth and P. F. Crosland.

B.P. 632,108. Appl. 28.11.47. Conv. (U.S.A.) 13.3.47. Acc. 16.11.49.

Curing synthetic copolymers containing allylic unsaturation. To: United States Rubber Co.

Chemical means for facilitating the curing to the hard, insoluble, infusible state of applied films of acetone soluble copolymers derived from vinyl benzene and a diallylic ester of fumaric acid.

B.P. 632,114. Appl. 16.12.47. Conv. (U.S.A.) 21.12.46. Acc. 16.11.49.

Plasticized vinylidene chloride copolymers of the organic solvent soluble type. To: British Cellophane, Ltd.

B.P. 632,208. Appl. 26.2.47. Acc. 17.11.49.

Production of cellular materials from rubber, plastic and bituminous compositions. A. K. Unsworth and A. G. Goodchild, and A. Cooper. To: Expanded Rubber Co., Ltd.

Blowing agents for the production of cellular (expanded) compounds, in particular hydrogen peroxide and organic peroxides such as urea-acetyl benzoyl-peroxide are quoted as particularly suitable agents which work well below the temperature at which rapid vulcanization takes place.

B.P. 632,240. Appl. 22.5.47. Acc. 18.11.49.

Manufacture of artificial filaments, fibres, threads and the like filamentary products. D. Traill and J. E. L. Thomas. To: I.C.I., Ltd.

Refers to fibres, filaments, etc., spun from alkaline peanut globulin solutions.

B.P. 632,270. Appl. 22.9.47. Conv. (U.S.A.) 25.9.46. Acc. 18.11.49.

Stabilized polythene compositions. E. J. du Pont de Nemours and Co.

Polythene compositions stabilized with dilauryl beta-thio-dipropionate.

B.P. 632,316. Appl. 4.3.47. Conv. (U.S.A.) 5.3.46. Acc. 21.11.49.

Producing a solid ethylene polymer and the product resulting therefrom. Standard Oil Co.

0.01 per cent. + 10 per cent. of a peroxide of the general formula

$$R_1O{-}\overset{\overset{O}{\|}}{C}{-}O{-}O{-}\overset{\overset{O}{\|}}{C}{-}OR_2$$

is used as catalyst for the polymerization of ethylene.

B.P. 632,335. Appl. 27.6.47. Conv. (U.S.A.) 28.6.46. Acc. 21.11.49.

Amino-formaldehyde resin compositions incorporating latent curing agents. D. E. Nagy. To: British Industrial Plastics, Ltd.

Composition comprising a fusible amino-formaldehyde resin with an acyl carbamyl-guanidine salt or an acyl quanylurea salt incorporated as curing agent.

B.P.632,364. Appl. 2.5.46. Conv. (U.S.A.) 29.3.44. Acc. 28.11.49.

Screw press for mixing and extruding synthetic plastic materials, more particularly thermoplastic materials. To: S.P.A. Lavorazione Materie Plastiche.

Twin-screw extruder for plastics with inter-meshing screws. Both screws decrease in diameter seen from the feeding end and have a parallel cylindrical section in the neighbourhood of the outlet die. Either constant or progressively decreasing pitch of screw threads.

B.P. 632,427. Appl. 3.1.46. Acc. 28.11.49.

Toy animals, dolls, puppets and like figures or parts thereof. P. Lambda.

Dolls, etc., made with wire-frame skeleton covered with rubber or thermoplastic compounds in the form of an uninterrupted continuous layer.

B.P. 632,645. Appl. 1.4.46. Conv. (Switzerland) 6.4.45 25.1.46. Acc. 28.11.49.

Preparing moulding powder. M. Haefeli.

Manufacture of protheses or artificial limbs, especially dental protheses from thermoplastic materials in monomeric form mixed with polymerizable liquids. Articles are polymerized in moulds under heat and pressure.

B.P. 632,661. Appl. 2.10.46. Acc. 28.11.49.

Preparation of vinylpyridines. L. F. Salisbury. To: E. I. du Pont de Nemours and Co.

Dehydration of beta-pyridyl and beta-quinolethanol compounds to give substantially quantitative yields of the corresponding vinylpyridine compound.

B.P. 632,757. Appl. 8.9.47. Acc. 5.12.49.

New plastic compositions. H. G. Reid To: I.C.I. Ltd.

Compositions comprising one or more thermoplastic materials and esters derived from 3, 5, 5 trimethyl-1-hexanol and a monobasic organic acid.

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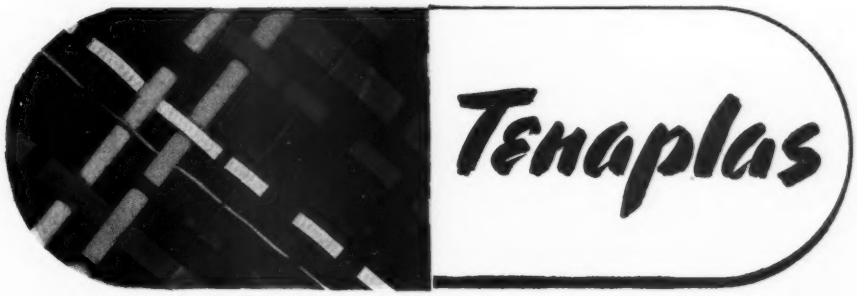

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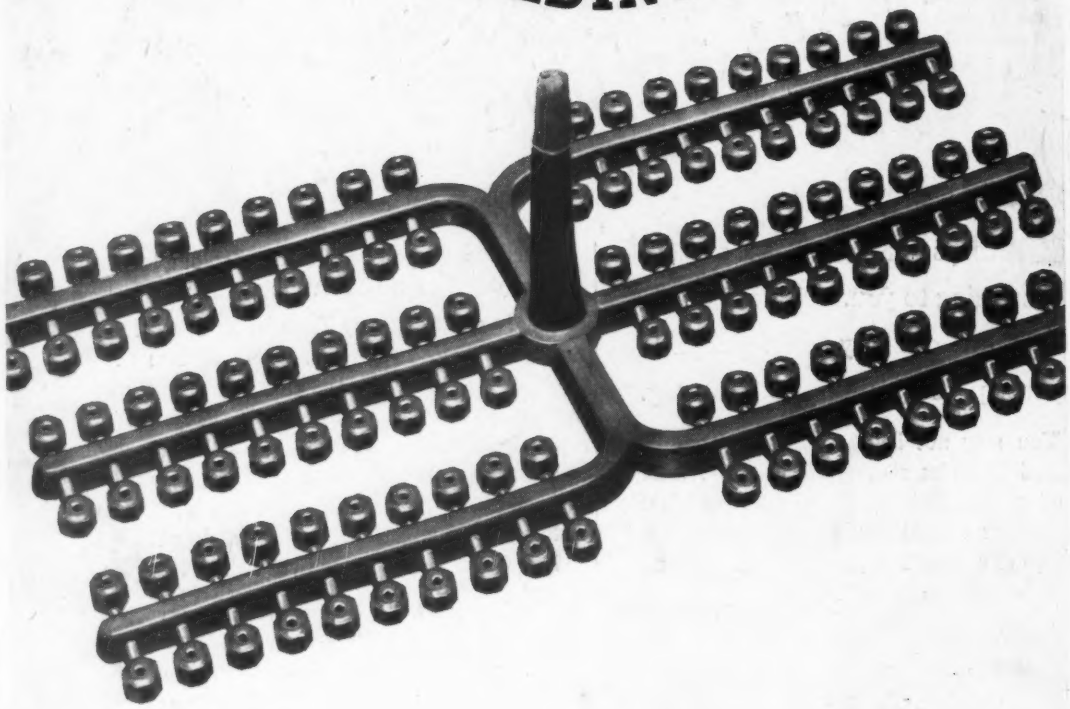

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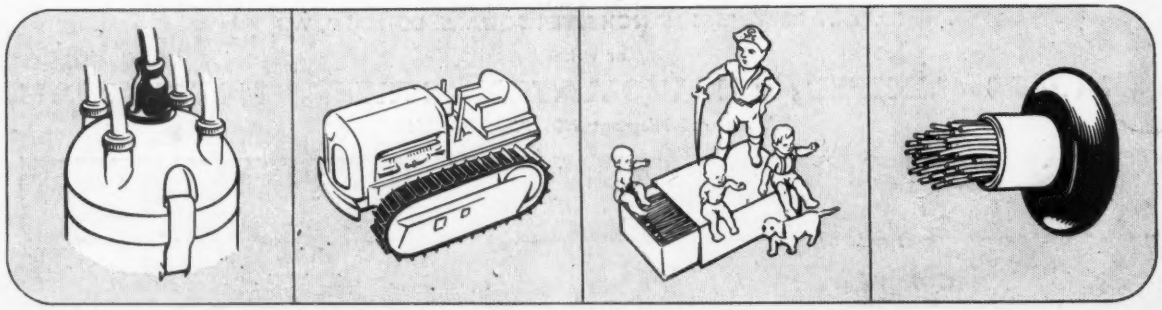
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